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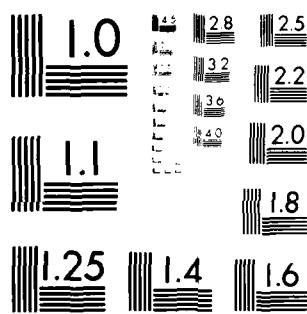
NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS
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NEW ENGLAND DIV SEP 79

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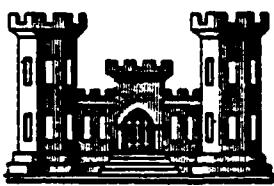
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AD-A146 990

MASSACHUSETTS COASTAL BASIN
GLOUCESTER, MASSACHUSETTS

HASKELL POND DAM
MA 00155

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM



DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

SEPTEMBER 1979

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) Haskell Pond Dam consists of an earth embankment with an overflow spillway at the left abutment. The overall length of the dam is 480 feet and it has a maximum height of 43 ft. The dam is considered to be in fair condition. Based on the "intermediate" size and "high" hazard potential classifications, the test flood for this dam is the PMF.		

MASSACHUSETTS-RHODE ISLAND COASTAL BASIN
GLOUCESTER, MASSACHUSETTS

HASKELL POND DAM
MA 00155

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

SEPTEMBER 1979

PHASE I INVESTIGATION REPORT
NATIONAL DAM INSPECTION PROGRAM

Identification No.:	MA 00155
Name of Dam:	Haskell Pond
Town:	Gloucester
County:	Essex
State:	Massachusetts
Stream:	Walker Creek
Date of Site Visit:	21 August 1979

BRIEF ASSESSMENT

Haskell Pond Dam consists of an earth embankment with an overflow spillway at the left abutment, an intake structure on the upstream side and an outlet structure at the downstream toe. There are two outlet pipes through the dam. The overall length of the dam is 480 ft. and it has a maximum height of 43 ft. The project was completed in 1903 to provide water supply for the City of Gloucester.

Due to the extent of downstream development that would be affected in the event the dam were to fail, Haskell Pond Dam is confirmed as having a "high" hazard potential in accordance with Corps of Engineers guidelines.

The dam is considered to be in fair condition because a visual examination of the intake gatehouse could not be made and the owner was unwilling to demonstrate the operation of the gate valves. However, there was no evidence of settlement, lateral movement or other signs of structural failure, or other conditions which would warrant urgent remedial action.

Based on the "intermediate" size and "high" hazard potential classifications in accordance with Corps of Engineers guidelines, the test flood for this dam is the Probable Maximum Flood (PMF). Hydraulic analyses indicate that the test flood inflow would be 1,400 cfs, based on an inflow rate of 2,240 csm for the drainage area. The discharge capacity of the spillway and a separate natural diversion saddle was determined with the water level at the top of the dam for two conditions.

With the existing fixed flashboards in place in the spillway the outflow capacity is 325 cfs, which is 45

percent of the estimated test flood outflow of 720 cfs. The dam embankment would be overtopped by about 0.4 ft. The outflow capacity could be increased to 535 cfs (72 percent of the 740 cfs test flood outflow) if the existing flashboards were removed. The estimated resulting overtopping of the embankment would then be reduced to 0.2 ft.

The City of Gloucester, owner of the dam should engage a registered professional engineer to 1) perform a detailed hydraulic/hydrologic investigation to determine spillway discharge adequacy and embankment overtopping potential at this facility and 2) assess the potential for a failure of the dam during a seismic event. Any necessary modifications to the facility resulting from the investigations, should be implemented by the Owner within one year after receipt of this report.

Remedial measures, including supplying access to the intake gatehouse, making sure gate valves for pipes through the embankment can be closed at the upstream end, removing flashboards and timber beams from across the spillway, completing brush removal, monitoring seepage near the toe on the right side, clearing vegetation along the spillway discharge channel and repairing the gatehouses and reservoir drain gate valves, as outlined in Section 7.3, should be implemented by the Owner within one year after receipt of this report. The Owner should also prepare a formal operations and maintenance manual for the dam and update the emergency preparedness plan.

HALEY & ALDRICH, INC.
by:

Harl Aldrich

Harl Aldrich
President



PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the office of Chief of Engineers, Washington, DC 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I Investigations are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the test flood is based on the estimated "probable maximum flood" for the region (greatest reasonably possible storm run-off), or a fraction thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential. Consideration of downstream flooding other than in the event of a dam failure is beyond the scope of this investigation.

The Phase I Investigation does not include an assessment of the need for fences, gates, no-trespassing signs, repairs to existing fences and railings and other items which may be needed to minimize trespass and provide greater security for the facility and safety to the public. An evaluation of the project for compliance with OSHA rules and regulations is also excluded.

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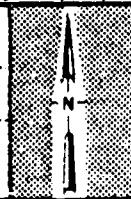


1. Overview of Haskell Pond Dam

FILE NO. 4270 A32



DAM: Haskell Pond
IDENTIFICATION NO. MA 00155



LOCATION MAP
USGS QUADRANGLE
GLoucester, MA

APPROX. SCALE: 1" = 2000'

PHASE I INVESTIGATION REPORT
NATIONAL DAM INSPECTION PROGRAM

SECTION I - PROJECT INFORMATION

1.1 General

a. Authority. Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region.

Haley & Aldrich, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of Massachusetts. Authorization and notice to proceed were issued to Haley & Aldrich, Inc. under a letter dated 28 November 1978 from Colonel Max B. Scheider, Corps of Engineers. Contract No. DACW33-79-C-0018 has been assigned by the Corps of Engineers for this work. Camp, Dresser & McKee, Inc. was retained as consultant to Haley & Aldrich, Inc. on the structural, mechanical/electrical and hydraulic/hydrologic aspects of the Investigation.

b. Purpose of Inspection. The primary purposes of the National Dam Inspection Program are to:

1. Perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.
2. Encourage and prepare the states to initiate effective dam safety programs for non-Federal dams.
3. Update, verify and complete the National Inventory of Dams.

1.2 Description of Project

a. Location. The dam is located at the northern end of Haskell Pond in Gloucester, Massachusetts, as shown on the Location Map, page vii. The latitude and longitude of the dam site are $N42^{\circ}36.9'$ and $W70^{\circ}44.3'$. Spillway discharge is conveyed by Walker Creek North approximately 2.5 miles to the Essex Bay tidal basin of the Atlantic Ocean.

b. Description of Dam and Appurtenances. Haskell Pond Dam consists of an earth embankment with an overflow spillway at the left abutment, an intake structure on the upstream side and an outlet structure at the downstream toe. The overall length of the dam is approximately 480 ft., and its maximum height is about 43 ft. There are two outlet pipes at the dam site. The general configuration of the project is shown on the "Site Plan Sketch", page C-1.

Cross-sections of the earth embankment are given on the drawings included as pages B-17 and B-18. These drawings give the embankment side slopes and details of the concrete core wall contained within the embankment. The crest of the dam was measured to be about 17 ft. wide, and a 10 ft. wide unpaved road runs its length. The entire upstream slope is paved with rough cut granite stones, except for the top 2.5 ft. (measured vertically) which is paved with concrete to a grade 3 to 6 in. lower than the top of the dam. The dam embankment is shown on Photos No. 1, 2, 3, 5, 6 and 7.

The concrete spillway is a broad-crested weir with the fixed crest 4.4 ft. below the top of dam. Fixed wooden flashboards totalling 1.6 ft. in height are installed across the 14.0 ft. long spillway. The spillway is shown on Photos No. 8 and 9.

The concrete intake structure below the brick gatehouse on the upstream side of the dam has 4 open intake ports spaced 6 ft. apart vertically, as shown in plan on page B-17. A 20-in. supply main and a 12-in. reservoir drain pipe run from open gate valves at the base of the intake structure through the embankment under full pressure to a concrete chamber below the brick outlet gatehouse.

The 20-in. automatic overflow pipe from the intake structure to the spillway shown in plan on page B-18 has been blocked with concrete at the spillway end.

The 20-in. supply ~~main~~ feeds an adjacent pumping station from which water can be pumped into the Gloucester Water Supply system. The gatehouses and pumping station are shown on Photos No. 4 and 11. A 12-in. blow-off pipe from the outlet gatehouse discharges into the downstream channel at the end of the spillway discharge chute shown on Photo No. 10.

c. Size Classification. Haskell Pond Dam has an estimated maximum storage capacity of 1,800 acre-ft. at the top of the dam embankment. The corresponding maximum hydraulic height is about 43 ft. According to classification guidelines established by the Corps of Engineers, storage of from 1,000 to 50,000 acre-ft. and a height of from 40 to 100 ft. classifies this dam in the "intermediate" size category.

d. Hazard Classification. Based on the Phase I investigation and dam failure analysis (Section 5.1f), in accordance with Corps of Engineers guidelines, Haskell Pond Dam was found to have a "high" hazard potential. If the dam were to fail, a water supply pump station, State Highway Route 133 and about twenty residential dwellings along the flood plain of Walker Creek would be subject to serious flooding. Therefore, the potential for loss of life and extensive economic loss to public and private properties is high.

e. Ownership. The name, address and phone number of the current owner are:

City of Gloucester
Public Works Department
Poplar Street
Gloucester, MA 01930
Phone: (617) 283-5940

The dam has always been owned by the City of Gloucester. Mr. Robert Martinack is the acting director of the Public Works Department.

f. Operator. Mr. Wilfred Burke, Chief Operator, is responsible for operation, maintenance and safety of the dam. He has been associated with the Public

Works Department since about 1948. His office phone number is (617) 283-5940.

g. Purpose. Haskell Pond Dam was built and is used for impounding a water supply for the City of Gloucester.

h. Design and Construction History. The dam was designed by Herman W. Spooner, Civil Engineer, for the Board of Water Commissioners of the City of Gloucester. It was constructed by Coleman Bros., Contractors, from 1902 to 1903. Relevant portions of the Engineer's Report dated 1 December 1903, including photographs taken during construction, are included in Appendix B.

In 1958, the concrete paving at the top of the upstream slope was added. The flashboard supports were rebuilt to the present configuration in 1962.

i. Normal Operational Procedures. Water Department personnel man the pumping station at the toe of the dam during daylight hours. In addition, responsible personnel visit the dam each day. The dam is therefore under observation during daylight hours. While there is no written procedure for the maintenance and operation of the dam, the grass at the toe of the dam is kept mowed, and the weeds and brush are removed from the downstream face of the dam approximately every other year.

1.3 Pertinent Data

All elevations reported herein are based on or were measured relative to elevations appearing on the original drawings of the dam. After discussions with the Gloucester City Engineer, who compared the elevations given on the original drawings with those appearing on aerial photo maps with superimposed contours, it seemed reasonable to assume that the elevations on the drawings are based on National Geodetic Vertical Datum (NGVD). This assumption agrees with information given on the USGS Gloucester Quadrangle Map, but there was no nearby benchmark to confirm the datum assumption.

a. Drainage Area. Haskell Pond Dam is located about 3,000 ft. south of State Highway 133. The total drainage area of the pond is estimated to be 0.63 square miles and is shown on page D-1. A relative low saddle at an elevation of approximately El. 115 is located on the southwest side of the pond. Some water

will flow over this saddle into Cedar Swamp in Manchester during high water stages.

Ground elevation in the watershed of Haskell Pond vary from a low of El. 100 near the dam to a high of El. 270 on Mount Ann. With the exception of the pond surface (about 0.10 sq. mi.), the drainage area, in general, consists of rolling woodlands.

b. Discharge at Dam Site

1. Outlet works..... 20-in. dia. water supply line and 12-in. dia. reservoir drain pipe
2. Maximum known flood discharge at dam site..... Not available
3. Ungated spillway capacity at top of dam (with existing flashboards)..... 325 cfs* at El. 117.0 (without flashboards)..... 535 cfs* at El. 117.0
4. Ungated spillway capacity at test flood pool elevation (with existing flashboards)..... 490 cfs** at El. 117.4 (without flashboards)..... 630 cfs** at El. 117.2
5. Gated spillway capacity at normal pool elevation.... Not applicable
6. Gated spillway capacity at test flood pool elevation. Not applicable
7. Total spillway capacity at test flood pool elevation (with existing flashboards)..... 490 cfs** at El. 117.4 (without flashboards)..... 630 cfs** at El. 117.2
8. Total project discharge at test flood pool elevation (with existing flashboards)..... 720 cfs*** at El. 117.4 (without flashboards)..... 740 cfs*** at El. 117.2

*Includes 100 cfs flow over natural diversion saddle to Cedar Swamp

**Includes flow over natural diversion saddle to Cedar Swamp

***Includes flow over saddle, dam and banks

c. Elevation (ft. above NGVD)

1. Streambed at downstream toe of dam..... 74.0
2. Maximum tailwater..... Unknown
3. Upstream portal invert diversion tunnel..... Not applicable
4. Normal pool..... 112.6
5. Full flood control pool... Not applicable
6. Spillway crest
(without flashboards)..... 112.6
(with existing flash-
boards)..... 114.2
7. Design surcharge-original
design..... Unknown
8. Top of dam..... 117.0
9. Test flood design sur-
charge
(without flashboards)..... 117.17
(with existing flash-
boards)..... 117.35

d. Reservoir

1. Length of maximum pool.... 0.80 mi. (Est.)
2. Length of recreation pool. 0.75 mi. (Est.)
3. Length of flood control
pool..... Not applicable

e. Storage (acre-feet)

1. Normal pool..... 1,520
2. Flood control pool..... Not applicable
3. Spillway crest
(without flashboards)..... 1,520
(with existing flash-
boards)..... 1,620
4. Top of dam..... 1,800
5. Test flood pool
(without flashboards)..... 1,810
(with existing flash-
boards)..... 1,830

f. Reservoir Surface (acres)

1. Normal pool..... 60

- 2. Flood control pool..... Not applicable
- 3. Spillway crest
 - (without flashboards)..... 60
 - (with existing flashboards)..... 68
- 4. Top of dam..... 82
- 5. Test flood pool..... 83 to 84

g. Dam

- 1. Type..... Earth embankment
- 2. Length..... 480 ft.
- 3. Height..... 43 ft. maximum
- 4. Top width..... 17 ft.
- 5. Side slopes..... U/S, 2H to 1V above
El. 92, 2.5H to 1V
below El. 92; D/S,
2H to 1V
- 6. Zoning..... Unknown
- 7. Impervious core..... Concrete core wall
- 8. Cutoff..... Unknown
- 9. Grout curtain..... Unknown
- 10. Other..... Completed in 1903

h. Diversion and Regulating Tunnel. Not applicable

i. Spillway

- 1. Type..... Stone masonry over-flow type with concrete sidewalls and fixed 1.6 ft. high wooden flash-boards
- 2. Length of weir..... 14 ft.
- 3. Crest elevation..... 114.2 (top of flash-boards)
- 4. Gates..... None
- 5. U/S channel..... 22 ft. long, 14 ft. wide between concrete walls, bottom lined with stone masonry
- 6. D/S channel..... Mortared stone masonry between sidewalls for first 28 ft. length, transitioning to a paved trapezoidal chute which ends with a 3 ft. high drop structure. Total length 250 ft.

j. Regulating Outlets. A 12-in. diameter reservoir drain extends from invert El. 74.5 at the intake structure through the dam to the outlet structure. From below the outlet gatehouse, a 12-in. blowoff traverses the area downstream of the dam until it reaches the lower regions of the spillway discharge chute. Refer to the drawings on pages B-17, B-18 and C-1.

The drain pipe is gated at both the inlet and outlet gatehouses. The inlet gatehouse was not available for inspection. However, it is reported that the gate at this location is in the open position. The gate at the outlet gatehouse is shut and has not been operated for some time. This drain is therefore believed not to be operational.

The reservoir is normally lowered by using blowoffs from the 20-in. diameter water transmission main downstream of this facility. The invert of the supply main is El. 77.0 at the intake structure. The gate at the outlet gatehouse controlling flow from the supply main to the 12-in. blowoff was closed. The observed blowoff outlet was an 8-in. diameter pipe which would discharge into the brook below the dam. This line is controlled by a gate located in a manhole adjacent to the pumping station.

The 20-in. overflow pipe from the intake structure to the spillway (shown on the drawings included as page B-17 and B-18) is blocked with concrete at the spillway.

SECTION 2 - ENGINEERING DATA

2.1 Design Data

Record drawings of the project and a brief report to the Board of Water Commissioners of the City of Gloucester by the engineer, Herman W. Spooner, constitute the available design data.

2.2 Construction Data

The engineer's report by Herman W. Spooner briefly describes the construction sequence and contains several photographs taken at various stages of construction.

2.3 Operation Data

No operational records other than reservoir level elevations were located.

2.4 Evaluation of Data

a. Availability. A list of the engineering data available for use in preparing this report is included on page B-1. Selected documents from the listing are also included in Appendix B.

b. Adequacy. There was a lack of engineering data available to aid in the evaluation of Haskell Pond Dam. This Phase I assessment was therefore based primarily on visual examination, preliminary hydraulic and hydrologic computations, consideration of past performance and application of engineering judgement.

c. Validity. The information contained in the engineering data may generally be considered valid.

SECTION 3 - VISUAL EXAMINATION

3.1 Findings

a. General. The Phase I visual examination of Haskell Pond Dam was conducted on 21 August 1979. The upstream water surface elevation was measured with a hand level to be 6.8 ft. below the top of the flashboards at the spillway that day, so the spillway weir and channels were exposed and dry. This water level in the reservoir corresponds to a reading of about 32.8 ft. on the guage attached to the circular intake structure upstream of the dam.

In general, the project was found to be in fair condition, mainly due to the lack of maintenance of the operating facilities. The ability to operate gate valves at the upstream and downstream ends of the supply pipe and drain pipe through the embankment was not demonstrated.

A visual inspection check list is included in Appendix A and selected photographs of the project are given in Appendix C. A "Site Plan Sketch", page C-1, shows the direction of view for each photograph.

b. Dam. The upstream slope of the dam, Photos No. 2 and 3, is paved with rough cut granite stones, rectangular in shape and measuring approximately 12 to 15 in. by 15 to 24 in. There is no mortar in the joints between stones, but generally the stone paving appears to be in good condition. Joints between the stones are occasionally 4 to 5 in. in width and the depth is commonly 4 to 6 in. At some locations where the underlying material has washed out, the joints are 10 to 12 in. deep. Minor vegetation is growing in the joints near the top of the slope. In general, the stones appear to have slid downslope somewhat and in so doing have tilted slightly.

Immediately opposite the intake structure (gate chamber), the riprap has a somewhat smoother appearance and the joints between the granite blocks have been partially filled with 1/2 to 1 in. screened stone. This area was reported repaired in 1964 to correct movement of the stone due to settlement.

There is an outcrop of granite bedrock located approximately 20 ft. right of the spillway, Photo No. 2. This outcrop is indicated on a drawing (page B-18) to have been grouted at the time of the construction of the dam.

The concrete paving on the upstream slope at the top of the dam was reportedly placed in 1958 to correct an erosion situation which had apparently developed above the granite block riprap. The slabs measure 4.5 ft. up the slope and have construction joints spaced about 9.5 ft. The concrete paving is generally in good condition with water stains and only minor cracks, Photos No. 2 and 3.

On the top of the dam there is a one-lane gravel roadway with a thin layer of broken rock as a surface, Photo No. 1. The top of the dam measured about 17 ft. in width at the right end. The gravel roadway itself, which is about 3 to 6 in. higher than the shoulder areas, is about 10 ft. in width. The crest of the dam has been cleared of brush over about two-thirds of its length at the right end. At the left end, at the location of an abandoned cast iron emergency supply pipe which crosses the crest of the dam and the spillway, brush has not yet been cleared.

There was no visible evidence of cracks, settlement, lateral movement or other signs that there were embankment stability problems. There was no evidence of significant erosion at the crest of the embankment, or settlement of the crest. The alignment of the crest both vertically and horizontally is excellent, Photos No. 2, 3 and 5.

At the time of the site visit, workmen were clearing the brush toward the left end of the dam, Photos No. 5 and 6. For the most part, brush had been cleared over about two-thirds of the downstream slope except in localized areas where hornets' nests had been encountered. In these areas the brush has been left in place. Brush which is being cleared is typically from 2 to 4 ft. in height, although there are occasional maple saplings as high as 5 and 6 ft. Mr. Marchant of the Gloucester Public Works Department stated that the brush is cleared from the embankment in the fall of each year, so presumably the existing brush has grown up during this spring-

summer period.

There was no evidence of slips, slope failures or significant erosion of the downstream slope near the top of the embankment, on examination from the crest. The downstream slope was examined from the toe of slope and relatively systematically at several locations on the embankment where the area had been cleared. No evidence of sloughing, erosion, bulging or other evidence of slope failure was observed. At one or two locations, motorbikes have traveled up the face of the downstream slope and have caused minor erosion of the earth. The City of Gloucester has placed a little fill material at the crest of the embankment to discourage the motorbikes. There was no seepage evident on the embankment slope itself. No animal holes were observed.

The ground at the toe of the embankment and somewhat beyond is moist starting at a point approximately 40 ft. left of the outlet gatehouse, Photo No. 7. Between the gatehouse and the toe of the dam and immediately left and right of the gatehouse, the area is moist and rutted from vehicle traffic.

Downstream of the dam at the right there is an area covered with brush where the ground is swampy and wet. This moist area is just beyond the toe of the dam and extends from behind the gatehouse all the way to the right abutment, Photos No. 7 and 10. There is a 12-in. diameter asphalt coated corrugated metal pipe located about 30 ft. from the outlet gatehouse which was constructed 5 or 6 years ago to drain the swampy area. Flow into this pipe is presently estimated to be two gallons per minute. The water is clear; there is no evidence of turbidity. There is no way to determine where the water is emerging from the ground.

c. Appurtenant Structures. The spillway structure at the left abutment of the dam is in good condition. One tree is overhanging the spillway on the left side. The top of the walls at the entrance to the spillway have some deterioration present, probably due to the continued battering of the log boom against the concrete, Photo No. 8. The approach area appears to be free of vegetation. Semi-permanent flashboards are in place, forming the present weir of the spillway.

The height of the flashboards is 1.6 ft.

It appears that the remains of an old timber bridge across the spillway are present just downstream of the flashboards. The timbers are in poor condition. The upstream timber forms an additional support for the flashboards. Vegetation is present in the area just downstream of the flashboards at the invert of the spillway, Photo No. 9. Only slight efflorescence was observed on the concrete side walls.

The chute discharge channel from the spillway appears to be in good condition. The invert of the chute is stone masonry, Photos No. 8, 9 and 10. Vegetation is very heavy on the left side and somewhat lighter on the right side of the chute, Photo No. 10. Many trees overhang the channel from the left side. It appears that there has been a buildup of earth at the transition between the spillway and the chute on the right side of the discharge channel, Photos No. 8 and 9. A small amount of loose overhanging rock is present at the upstream end of the chute on the left side.

The intake gatehouse is currently only accessible by boat, Photo No. 3. Consequently, the interior of the gatehouse was not observed. The gate valves controlling the four intake ports, 12-in. line and 20-in. line are all reported to be open. As viewed from the dam, Photo No. 4, the roof of the gatehouse appeared to have depressions indicating possible problems. The top of the concrete substructure has been covered with mortar. This mortar appears to be loose and spalling. The remaining exposed portion of this substructure is weathered, exposing aggregate in the concrete.

The roof of the outlet gatehouse has many bullet marks and a few missing slates. The portion of the roof facing the dam needs to have the major portion of the slates replaced. The brickwork is in good condition. There are some bullet marks and some minor loss of mortar in the joints. Traces of efflorescence were observed on the brickwork. The concrete base is sound, but there is some surface deterioration. The exterior of the outlet gatehouse is shown on Photos No. 4, 5, 6 and 11.

The interior of the outlet gatehouse has been used as a storage area, and there is some debris present on the floor. Three gate valves were present within the building and they appeared to be maintained. One of the manually

operated valves controls the original reservoir drain. The owner's representative declined to operate the drain valve when requested to because he feared he might not be able to close the valve after opening it. It was reported to be operable though. The supply main valves were open, and water was flowing from the reservoir.

The pumping station downstream of the outlet gate-house, Photo No. 11, is in good condition. It appears to be well maintained and no structural deficiencies were noted. The building contains two pumps capable of transmitting water to other reservoirs. The electric powered pump visually appeared to be in good operating condition. The gasoline powered pump is currently not in use.

d. Reservoir Area. The Haskell Pond reservoir area is heavily wooded throughout, and the reservoir shoreline is predominantly rock outcrops with cobbles and boulders. There is no possibility for significant landslides or rock falls into the reservoir and no significant potential for erosion from the slopes into the reservoir. The low natural saddle to Cedar Swamp was not easily accessible for visual observation.

e. Downstream Channel. The channel, locally called Walker Creek, flows into Essex Bay in Gloucester, at the downstream distance of about 2.5 miles from the dam. Within this distance, the channel crosses a state highway (Route 133) and two local roads, Walker and Concord Streets.

The mortared stone masonry apron is approximately 28 ft. long and 14 ft. wide between the side walls, Photos No. 9. The paved spillway channel continues for about 250 ft. beyond the apron, Photo No. 10. A 90 ft. length of the outlet channel, starting from a point approximately 50 ft. downstream of the spillway crest, is on a grade of about 30 percent. The channel bottom gradient then flattens out at a point 40 ft. downstream from the toe of the dam.

The paved spillway channel ends at a 3 ft. high drop structure where a 12-in. diameter reservoir drain pipe also terminates. Beyond this point, the downstream channel has a 5 ft. bottom width and a 2.5 ft. depth for the portion which meanders through dense woodland along Forest Lane.

About 300 ft. upstream from the State Highway (Route 133), the channel flows through a relatively small pond which has a normal surface area of 1.4 acres. The outlet from this pond is over a spillway which is 5.5 ft. in length with a side wall height of 1.2 ft. Discharge from the spillway cascades over four steps of masonry construction into the stream channel which is 7 ft. below the spillway crest.

About 500 ft. downstream of Route 133 the channel flows through a tidal plain which has a width varying from 250 ft. to 400 ft.

The type of opening and opening dimensions under Route 133, Walker Street and Concord Street are shown below.

<u>Location</u>	<u>Shape of Opening</u>	<u>Dimensions</u>
Route 133	Upstream: rectangular	4.3 ft. wide by 6 ft. high
	Downstream: circular (corrugated metal)	6 ft. dia.
Walker Street	Rectangular (timber bridge)	10 ft. wide by 6 ft. high
Concord Street	Rectangular (top steel grated)	13 ft. wide by 10.8 ft. high

The area along Walker Creek is, in general, sparsely developed. Several dwellings in the tidal plain were observed in the section between Walker Street and Concord Street.

3.2 Evaluation

Based on the visual examination conducted on 21 August 1979, the earth embankment of Haskell Pond Dam is considered to be in good condition. The spillway, gatehouses and pumping station appear to be in satisfactory condition. Only minor deficiencies were noted for these appurtenant structures. However, the supply and drain pipes through

the embankment are under continuous head, and the ability to open and close gate valves at the intake and outlet gatehouses was not demonstrated. Inability to operate the gate valves is a condition which could adversely affect the safety of the dam. Due to this lack of maintenance of the gate valves, the overall condition of the project can only be considered fair.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 Procedures

In general, there is no written procedure for the operation of the dam.

4.2 Maintenance of Dam

The pumping station downstream of the dam is manned by the City of Gloucester Water Department Personnel. In addition, responsible persons visit the dam on a daily basis. The dam is therefore kept under observation during daylight hours. Grass at the toe of the dam is kept mowed on a continuing basis. Weeds and brush on the downstream face of the dam are cut approximately every other year. However, there is no written, formal procedure for maintenance of the dam.

4.3 Maintenance of Operating Facilities

As stated in Section 4.2, the dam is kept under observation during daylight hours. Maintenance is performed on the operating facilities on an as-needed basis. All control valves in the inlet gatehouse are reported to be open. In the outlet gatehouse the supply main valve is open and the two valves to the 12-in. blowoff pipe are closed. Changing the position of these valves from their normal positions was not demonstrated.

4.4 Description of any Warning System in Effect

The City of Gloucester maintains a listing of downstream residences in order that they may be warned in case of emergency. However, the listing is not current and needs updating. There is no other established warning system or emergency preparedness plan in effect for this structure.

4.5 Evaluation

Formal operational procedures and a maintenance program should be established for this dam. Maintenance of the operating facilities needs to be improved. Warning systems should be instituted and the emergency preparedness plan expanded.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. General. The dam consists of an earth embankment approximately 480 ft. in length with a concrete core wall and masonry lining on the upstream face of the embankment. The spillway was excavated through a ledge formation on the left bank. The present purpose of the dam is to provide water storage for water supply to the City of Gloucester. Operation of the reservoir, or pumpage of water from it, is coordinated with several other reservoirs which are part of the City's water supply system. In general, spillage from the reservoir seldomly occurs.

Water will flow from the reservoir into an adjacent basin (Cedar Swamp which is tributary to Sawmill Brook) over a saddle on the southwest side when the water surface level in Haskell Pond exceeds about El. 115 or 2 ft. below the top of the dam embankment. This saddle was not easily accessible for visual observation.

The downstream channel flows are affected by the tidal conditions in Essex Bay, which is connected to the Atlantic Ocean through Ipswich Bay.

b. Data Design. No hydrologic or hydraulic design data were available for this dam site.

c. Experience Data. No historical records were available on spillway discharges. However, it was verbally reported that the maximum water surface elevation in the reservoir was 7 in. above the flashboards or El. 114.9 for a short duration in 1977.

d. Visual Observations. During the site visit of 21 August 1979, the water surface in the pond was 6.8 ft. below the top of the stoplogs or El. 107.4. The flashboards were fixed at the spillway crest. The total height of the flashboards above the spillway crest is about 1.6 ft. The spillway crest length is 14.0 ft. but because of vertical supports for the flashboards the clear length is reduced to about 13.4 ft. Maximum

flow depth available over the flashboards without overtopping the dam embankment is 2.8 ft., but the top 1 ft. of this is blocked with a timber beam.

The approach channel to the spillway is paved with cement mortared stone masonry for a distance of about 22 ft. A 14-in. diameter log is chained at both ends to the sidewalls about 17 ft. upstream of the flashboards.

A section of the downstream channel, starting from the spillway, is paved with stone masonry for a distance of about 270 ft. Approximately one-half of this length is on a curved alignment along the contact between the downstream slope of the dam embankment and the abutting hillside. In this section, the bottom gradient seems extremely steep and the channel has a shallow depth. The paved channel ends at a 3 ft. high drop structure. The reservoir drain pipe also terminates at this point.

A pump station and a gatehouse are located in the flat area extending from the toe of the dam. An abandoned water supply pipe to the reservoir crosses over the dam embankment; this pipe was used to carry pumped water from neighboring towns during emergencies.

The natural stream bed is, in general, hardly visible through a heavily wooded valley. A small pond and a few dwellings were observed upstream of State Highway Route No. 133.

The information on the existing bridge openings were presented under Section 3.1.e, Downstream Channel. Between Walker and Concord Streets, several dwellings were located right on the tidal flood plain. The flow in the channel in the vicinity of Concord Street was in reverse direction on the day of the site visit due to a tidal action.

e. Test Flood Analysis. Based on the Corps of Engineers guidelines, the recommended test flood for "intermediate" size dams having a "high" hazard potential is the PMF (Probable Maximum Flood). The PMF was determined using Corps of Engineers Guidelines for Estimating Maximum Probable Discharge in the Phase I Safety Investigation. The watershed terrain was determined

to be 85 percent rolling and 15 percent flat (water surface). From this, an inflow rate of 2,240 cfs per square mile (csm) was interpolated for the drainage area of 0.63 square miles. The resulting PMF inflow is 1,400 cfs.

Surcharge-storage routing was performed through Haskell Pond for two conditions, using the stage discharge and area-volume curves shown in Appendix D. Water withdrawn from the pond through a 20-in. intake pipe, which is connected to a pump station, was ignored in this evaluation.

The test flood outflow for Condition 1, which assumes that the existing 1.6 ft. high flashboards are left in place, is estimated to be 720 cfs at a pond elevation of 117.4. About 290 cfs of the total outflow would discharge over the spillway, 200 cfs would be naturally diverted into Cedar Swamp over a saddle and the remaining 230 cfs would flow over the embankment and banks.

For Condition 2, which assumes no flashboards at the spillway crest, the total test flood outflow is estimated to be 740 cfs at El. 117.2. Of this total, 470 cfs would flow over the spillway, 160 cfs over the saddle and 110 cfs over the dam embankment and banks.

The outflow capacity from the pond, with the existing fixed flashboards in place and without overtopping the dam, is estimated to be 325 cfs. This is 45 percent of the estimated test flood outflow. The pond outlet capacity could be increased to 535 cfs or 72 percent of the test flood outflow if the existing flashboards were removed.

It can be concluded that the probability of the dam being overtopped is very small. However, removing the flashboards and timber beam across the spillway would further reduce the risk of the dam being overtopped.

The surcharge-storage routing is influenced by the estimated flow diversions over the saddle. The assumptions made here should be verified in future studies.

f. Dam Failure Analysis. Based on Corps of Engineers Guidelines for Estimating Dam Failure Hydrographs, and

assuming that a failure would occur along 40 percent of the dam embankment, the peak failure outflow is estimated to be 85,300 cfs. The maximum flow over the spillway just before failure occurs would be approximately 400 cfs, which would not cause flooding over the banks in the built up areas. Because of this prior condition, a failure could occur with people in the flood hazard area being unprepared.

A preliminary failure flood hydraulic profile, which is shown on page D-11, was developed after flood routing through the downstream channel. The following structures and areas are expected to be subject to serious flooding should a failure of Haskell Pond Dam occur (the estimated flood depths are shown in Appendix D, page D-12):

- (a) City of Gloucester water pump station which is located near the toe of the dam. This station is manned 12 hours per day, 7 days per week.
- (b) Two dwellings about 200 ft. upstream of Route 133; one on the right bank and the other on the left bank.
- (c) An about 400 ft. long section of State Highway Route 133; frequent traffic was observed on the road.
- (d) Seven dwellings between Route 133 and Walker Street all on the left bank..
- (e) The Walker Street timber bridge with a 10 ft. span and a 350 ft. long roadway embankment approach section to the bridge.
- (f) Thirteen dwellings between Walker Street and Concord Street. Some of these houses are right on the flood plain and small children were seen playing in the backyards.
- (g) The Concord Street steel bridge with a 13 ft. span and a 500 ft. long roadway embankment approach section to the bridge.

In conclusion, in the event of a dam failure, potential for loss of life exists and extensive public and private property damages are expected to occur. Therefore, the hazard potential classification of the dam, in accordance with Corps of Engineers guidelines, is high.

SECTION 6 - STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations. There was no visual evidence of settlement, lateral movement or other signs of structural instability in the earth embankment during the site examination on 21 August 1979. There was no visible evidence of spillway instability either at that time. The side walls of the spillway appeared plumb and no evidence of buckling or settlement was noted of the spillway base slab.

b. Design and Construction Data. A theoretical analysis of the stability of the embankment slopes was not possible due to the lack of pertinent design and construction data, in particular with reference to the properties of earth materials placed in the embankment. Nevertheless, given the embankment height, side slopes and the fact that it contains a central concrete core wall, the embankment can be expected to be stable under static load conditions.

c. Operating Records. Except for the apparent satisfactory performance of the facility since its completion in 1903, there are no operating records available to aid in the evaluation of structural stability for this dam.

d. Post-Construction Changes. There are no known modifications of the earth embankment or spillway which would affect its stability.

e. Seismic Stability. Haskell Pond Dam is located within a Seismic Zone 3. In accordance with Recommended Phase I Guidelines, suitable analysis made by equivalent static load methods should be on record for this dam. No such analyses have been made, and the structural stability of the embankment under seismic loading conditions is unknown.

The relatively low height of the spillway walls and the present condition of the spillway indicate that this structure would be adequate for seismic loading expected in this area.

SECTION 7 - ASSESSMENT, RECOMMENDATIONS
AND REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition. The visual examination of Haskell Pond Dam revealed that the structure was generally in good condition, but due to the lack of maintenance of the operating facilities, the project can only be considered in fair condition. However, there were no signs of impending structural failure or other conditions which would warrant urgent remedial action.

Based on the results of computations indicated in Appendix D and described in Section 5, the spillway is not capable of passing the test flood, which for this structure is the PMF. An inflow rate of 2,240 csm for the drainage area results in a test flood inflow of 1,400 cfs. The discharge capacity of the spillway and a separate natural diversion saddle with the water level at the top of dam and the fixed flashboards in place is 325 cfs. This is 45 percent of the estimated test flood outflow of 720 cfs and would result in the dam embankment being overtopped by about 0.4 ft.

The outflow capacity could be increased to 535 cfs (72 percent of the 740 cfs test flood outflow) if the existing flashboards were removed. The estimated resulting overtopping of the embankment would then be 0.2 ft.

b. Adequacy of Information. This evaluation of the dam is based primarily on visual examination, preliminary hydraulic and hydrologic computations, consideration of past performance and application of engineering judgement. Generally, the information available or obtained was adequate for the purposes of the Phase I assessment.

c. Urgency. The recommendations for additional investigations and remedial measures outlined in Section 7.2 and 7.3, respectively, should be undertaken by the Owner and completed within one year after receipt of this report.

d. Need for Additional Investigations. Additional investigations should be performed by the Owner as outlined in Section 7.2.

7.2 Recommendations

It is recommended that the City of Gloucester, owner of the dam, arrange for the following investigations to be undertaken by a registered professional engineer:

1. Perform detailed hydraulic/hydrologic investigation to determine spillway adequacy and overtopping potential. Further studies of flows from the low saddle to Cedar Swamp should be included in this investigation.
2. Assess the potential for a failure of the dam during a seismic event.

The owner should implement corrective measures as required based on the results of the above engineering investigations.

7.3 Remedial Measures

The project is considered to be in fair condition, and it is considered important that the following items be accomplished:

a. Operation and Maintenance Procedures. The following should be undertaken by the Owner:

1. Supply some means of access to the intake gatehouse.
2. Make sure that the supply and drain pipes through the embankment can be closed at the upstream end. The 12-in. drain valve should normally be closed at the upstream end.
3. Repair the 12-in. drain valve at the outlet gatehouse so that it can be operated without fear of not being able to close it after testing.
4. Remove flashboards and the remnants of the former footbridge from over the spillway until

adequate spillway capacity is provided.

5. Complete the removal of brush on the downstream slope of the earth embankment.
6. Clear brush from the swampy and wet area beyond the toe between the outlet gatehouse and the right abutment to allow a closer examination for determining where the water is emerging from the ground. Periodic measurements of flow into the corrugated metal drainage pipe should be initiated so that the rate of flow can be correlated with reservoir level.
7. Cut grass and weeds in the spillway discharge channel and remove overhanging trees.
8. Patch the concrete spalls at the top of the spillway concrete sidewalls.
9. Provide any necessary repairs to the roof and top of the substructure of the intake gatehouse.
10. Replace damaged and missing slates in the roof of the outlet gatehouse.
11. Remove debris from interior of the outlet gatehouse so that the gate valves are readily accessible in an emergency.
12. Prepare an operations and maintenance manual for the dam which includes provisions for annual technical inspection of the dam, for periodic operation of all gate valves, and for surveillance of the dam during periods of heavy precipitation and high reservoir water levels. The written procedures should delineate the routine operational procedures and maintenance work to be done on the dam to ensure safe, satisfactory operation and to minimize deterioration of the facility.
13. Update the formal emergency procedures plan and establish a warning system with local officials.

7.4 Alternatives

There are no practical recommended alternatives.

APPENDIX A - INSPECTION CHECK LIST

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<u>VISUAL INSPECTION CHECK LIST</u>	
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Outlet Works - Intake Channel and Intake Structure	A-4
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VISUAL INSPECTION PARTY ORGANIZATION

NATIONAL DAM INSPECTION PROGRAM

Dam: Haskell Pond

Date: 21 August 1979

Time: 0815-1200

Weather: Partly cloudy - Cool (60's F)

Water Surface Elevation Upstream: El. 107.4 (6.8 ft. below
top of flash-
boards)

Stream Flow: None

Inspection Party:

Harl P. Aldrich, Jr.	- Soils/Geology
Richard A. Brown	
Haley & Aldrich, Inc.	
A. Ulvi Gulbey	- Hydraulic/Hydrologic
Paul Keohan	
Roger H. Wood	- Structural/Mechanical
Camp, Dresser & McKee, Inc.	

Present During Inspection:

Wilfred Burke, Chief Operator, Gloucester Public Works Dept.
Jack Marchant, Gloucester Public Works Dept.

VISUAL INSPECTION CHECK LIST
NATIONAL DAM INSPECTION PROGRAM

DAM: Haskell Pond

DATE: 21 Aug 79

AREA EVALUATED	CONDITION
<u>DAM EMBANKMENT</u>	
Crest Elevation	El. 117.0 (Datum unknown, assumed to be NGVD)
Current Pool Elevation	El. 107.4
Maximum Impoundment to Date	At least El. 114.7 (0.5 ft. over flashboards) by high water mark on spillway walls
Surface Cracks	None observed
Pavement Condition	No pavement (single lane gravel road in good condition)
Movement or Settlement of Crest	None observed
Lateral Movement	None observed
Vertical Alignment	Good
Horizontal Alignment	Good
Condition at Abutment and at Concrete Structures	Satisfactory
Indications of Movement of Structural Items on Slopes	No structural items on slopes except intake structure which appears satisfactory (on separate foundation)
Trespassing on Slopes	Occasionally (some motorbikes) but area is posted "No Trespassing"
Animal Burrows in Embankment	None observed
Vegetation on Embankment	About two-thirds of the embankment has been cleared of brush; clearing continuing on date of examination. Brush typically 2 to 4 ft. high; said to be cleared every year; no trees
Sloughing or Erosion of Slopes or Abutments	Not significant (local minor erosion at motorbike tracks)
Rock Slope Protection- Riprap Features	Good condition; only 2-3 stones were dislodged; riprap is rough cut granite blocks generally rectangular and hand placed
Unusual Movement or Cracking at or near Toes	None observed

VISUAL INSPECTION CHECK LIST
NATIONAL DAM INSPECTION PROGRAM

DAM: Haskell Pond

DATE: 21 Aug 79

AREA EVALUATED	CONDITION
Unusual Embankment or Downstream Seepage	Some seepage estimated at 2 gpm noted below toe of dam at right end; water clear (see report)
Piping or Boils Foundation Drainage Features	None observed
Toe Drains	None known to exist
Instrumentation Systems	None known to exist
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DIS- CHARGE CHANNELS	
a. Approach Channel	
General Condition	Good. Quarry stone paving trans- itions to field stone paving. Bituminous concrete patch at transition
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	One tree on left side
Floor of Approach Channel	Mortared field stone in excellent condition
Other	Single log boom at entrance OK. Rusted chain anchorage
b. Weir and Training Walls	
General Condition of Concrete	Good, concrete sound. Surface has eroded, exposing angular aggre- gate
Rust or Staining	None
Spalling	Top surfaces of walls at entrance
Any Visible Reinforcing	None
Any Seepage or Efflo- rescence	Very slight at horizontal cold joint
Drain Holes	None observed

VISUAL INSPECTION CHECK LIST
NATIONAL DAM INSPECTION PROGRAM

DAM: Haskell Pond

DATE: 21 Aug 79

AREA EVALUATED	CONDITION
c. <u>Discharge Channel</u>	
General Condition	Poor
Loose Rock Overhanging Channel	Small amount near beginning on left side
Trees Overhanging Channel	Continuously on left side
Floor of Channel	Paved with mortared field stone. Vegetation including brush on each side of the center of the channel
Other Obstructions	Soil on right side at beginning of channel
e. <u>Weir and Flashboards</u>	Sawed stone sill and sides in excellent condition. Flashboards are 1-3/4 in. thick by 19-1/2 in. high in front, 32 in. high in back. Semi-permanent installation. Good condition. Two plywood patches in front. Reported two blowoff pipes half exposed beneath flashboards, presently plugged
f. <u>Bridge</u>	Two weathered stringers remain, with single weathered and deteriorated planks at each end. Stringer anchorage by two bent steel pins for each stringer at each end
<u>OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE</u>	
a. <u>Approach Channel</u>	Intake structure is located on the upstream slope of the dam in the submerged reservoir pool channel
b. <u>Intake Structure</u>	No access to structure, viewed from dam

VISUAL INSPECTION CHECK LIST
NATIONAL DAM INSPECTION PROGRAM

DAM: Haskell Pond DATE: 21 Aug 79

AREA EVALUATED	CONDITION
Condition of Concrete	Substructure concrete eroded. Top surface deteriorating - partially capped with mortar, but deteriorating underneath
Stop Logs and Slots	Unknown
Brickwork	Appears to be good from distance
Roof	Depressions in shingles indicate roof has deteriorated
Gates	Gates reported to be stuck in open position - inoperative
OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL	
a. <u>Outlet Structure</u>	
General Condition of Concrete	Sound, but surface deteriorated
Rust or Staining	None observed
Spalling	Surface spalling
Erosion or Cavitation	Not applicable
Visible Reinforcing	None observed
Any Seepage or Efflorescence	None observed
Condition at Joints	None observed
Drain holes	Not applicable
Brickwork	Good. Many bullet marks, some efflorescence
Roof	Appears to be multi bullet holes and missing slate on upstream side of roof
Gates	All marked. Blow-off is shut.
Other	Manual, self-contained bypass is shut. Manual self-contained outlet rising stem appears maintained
	Debris and storage on floor
b. <u>Outlet Channel</u>	
Channel	Conduits are buried

VISUAL INSPECTION CHECK LIST
NATIONAL DAM INSPECTION PROGRAM

DAM: Haskell Pond DATE: 21 Aug 79

AREA EVALUATED	CONDITION
Loose Rock or Trees Overhanging Channel	Not applicable
Condition of Discharge Channel	Not applicable

FILE NO. 4160

HALEY & ALDRICH, INC.
CAMBRIDGE MASSACHUSETTS

APPENDIX B - ENGINEERING DATA

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<u>PRIOR INSPECTION REPORTS</u>	
Summary reports on the 26 inspections from 23 April 1912 through 31 March 1969 by the Essex County Engineer	B-3
2 July 1971 report by the Mass. Department of Environmental Quality Engineering	B-10
<u>SELECTED DOCUMENTS</u>	
Portions of Engineer's Report to the Board of Water Commissioners of the City of Gloucester. 1 December 1903	B-12
Drawings No. 2 and 6 for Haskell's Brook Reservoir Dam, 1902 and 1903	B-17
<u>SKETCH</u>	
Field sketch with assumed elevations, Haley & Aldrich, Inc., 21 August 1979	B-19

LIST OF AVAILABLE DATA
HASSELL POND DAM

<u>Document</u>	<u>Content</u>	<u>Location*</u>
Engineer's Report to City of Gloucester, Herman W. Spooner, Civil Engineer, 1 December 1903	Summary progress report on construction of dam, in- cluding reservoir capacity data and 5 photographs of project	Essex County Engineers Office (1), Gloucester Public Works Department (2) and portions on pages B-12 through B-16
Record Drawings - Haskell's Brook Reservoir Dam, Herman W. Spooner, Engineer, Gloucester, MA, 1902-1903	No. 2 - "Plan and Cross- Section of a Proposed Dam and Appurtenances on the Line of Haskell's Brook", 20 May 1902 No. 6 - "Plan Showing Contours at Site of Haskell's Brook Reservoir Dam after Completion of Work", 1903	Gloucester Public Works Department (1) and pages B-17 and B-18
Inspection reports from 1912 through 1969, Gloucester D.2	Summary of 26 county in- spection reports	Essex County Engineers Office (1) and pages B-3 through B-9

LIST OF AVAILABLE DATA
HASKELL POND DAM (Cont.)

<u>Document</u>	<u>Content</u>	<u>Location*</u>
Inspection reports after 1969, Gloucester Dam No. 5-5-107-2	2 July 1971 state inspection report	Mass. Department of Environmental Quality Engineering (3) and page B-10
Gloucester reservoir levels	Haskell Pond levels	Gloucester Public Works Department (2)

* Addresses

- (1) Essex County Engineers Office
32 Federal Street
Salem, MA 01970
- (2) Gloucester Public Works Department
Poplar Street
Gloucester, MA 01930
- (3) Mass. Department of Environmental Quality Engineering
Division of Waterways
100 Nashua Street
Boston, MA 02114

O 108-5-C
D. 2 R. S P

COUNTY OF ESSEX, MASSACHUSETTS
ENGINEERING DEPARTMENT

Inspection of Dams, Reservoirs, and Stand Pipes

O 108-5
SUB NUMBER
D. 2 R. S
Neg. No. 487

Inspector L. C. Barker Date April 23, 1912 *Classification 1
City or Town Gloucester Location Haskell Brook south of Essex Cr

Owner Gloucester Water Works Use Water supply

Include such details as cover, cut of walls, paving, sodding, class of masonry, kind of cement, (nat. or port.) etc.

Material and Type Earth with a concrete core wall (42' high)

Elevations in feet: above (+) or below (-) full pond or reservoir level. (Cross out what does not apply.)

For Dam (Bed of stream below) Bottom of pond Bottom of spillway Top of dam Top of flash boards

For Res. or S. P. (Ground surface below) Bottom of res. Level of over flow pipe Top of res.

For dam Length in ft. 450 Top width in ft. 18 Pond area 62 acres Area of watershed 350 acres

For Res. or S. P. (Inside dimensions) Storage capacity 475,000,000 gals.

Length of overflow or spillway Outlet pipes (size and nature)

Stand pipe, thickness at base 4 in. 1 in. thick Pipe 1 in.

Foundation and details of construction.

Constructed by and date Coleman Bros. Contractors 1901-03 Engineer Henry W. Igoune Eng.
John W. Moran Asst.

Recent repairs and date

Evidence of leakage Undermined and worn in. This is now being repaired.

Condition Good, except a portion of the spillway outlet S. P. which is painted

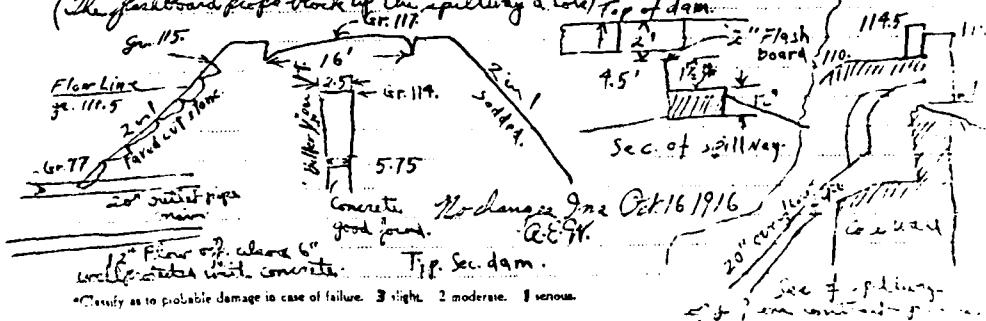
Topography of country below Narrow valley

Nature, extent, proximity, etc. of buildings, roads or other property in danger if failure should occur. Small dam
in houses below would be washed out.

Plans and data secured or available Full plans & specifications on file in office of
Gloucester Water Board.

Use separate sheet for sketches if necessary

Notes, sketches, sections, etc. The spillway is 14' wide between 2 masonry walls with flash boards to raise it height of water 1 1/2 ft.
(The floodboard projects back of the spillway a lot.) Top of dam Gr. 117



*Classify as to probable damage in case of failure. 3 slight, 2 moderate, 1 serious.

Gloucester D. 2

1917, March 26. Watershed 0.6 sq. m., Max. Ht. 36.5 ft. Apparent condition, Good.

1925, Nov. 12. R. R. Evans, Insp. Haskell's Pond Dam. G. W. W. This is an earth dam of considerable height and in good condition. The concrete spill way is ample and well paved and located beyond the dam in the natural ground. The only criticism to be made is that in order to hold the flash boards in place makeshift braces have been placed from the bridge above in such way that they unnecessarily obstruct the channel and might hold back the ice or other floating material.

1925 Report to Co. Comm. Same as above.

1928, Oct. 4. C. C. Barker, Insp. Dam on Haskell's Brook south of Essex Avenue, known as Haskell's Reservoir Dam, is owned by the Gloucester Water Works, and is part of their water supply system. I gave a copy of the notice to John W. Moran, Supt. I saw Mr. Bray at the pumping station which is at the base of the dam, and he went over the dam with me. Below the dam is a woody valley and in case of failure the main highway and one house several hundred feet below the dam would probably be washed out. Loss of life would likely occur. There have been no changes since the last inspection and conditions are the same. The dam is in good condition and well kept. The water level today is elevation 23.2 by the gauge at the dam.

1928 Report to Co. Comm. G. W. W. Dam at Haskell's Brook south of Essex Avenue, is in good condition.

1930, Sept. 17. C. C. Barker, Insp. Dam on Haskell's Brook south of Essex Avenue. Known as Haskell's Reservoir Dam, is owned by the Gloucester Water Works, and is part of their water supply system. I gave a copy of the notice to John W. Moran, Supt. No one inspected the dam with me. Several hundred feet below the dam is one house, and the old ice houses and the highway, which would be damaged. It is quite likely there would be loss of life. There have been no changes since the last inspection, and the conditions are the same. The dam is in good condition. The water level is 21 by the gauge. This is very low.

1930, Nov. 10. R. R. Evans, Insp. Water low. A fish trap is being put in outlet pipe and blow off pipe connected to allow drawing down lower. Excavation in progress is all below toe of slope and gate house. Spillway is unnecessarily obstructed.

1930 Report to Co. Comm. A dam on Haskell's Brook south of Essex Avenue, known as Haskell's Reservoir Dam, is a part of the Gloucester Water supply system and is an important structure. Some alterations in the pipe line below the dam were in progress at the time of inspection, and a fish trap was being inserted and connections changed to allow of drawing the water into the supply through what was originally the blow off pipe. Excavation for all these changes is below the toe of the dam and apparently not affecting the stability of it in any way. The spillway is obstructed to a considerable extent by bracing which has been put in beneath the bridge for the apparent purpose of holding the stop plank. Such obstruction is unnecessary, and a source of danger, and the bracing should be removed. The dam is apparently safe and in good condition.

Gloucester D. 2

1932, Aug. 2. C. C. Barker, Insp. I gave a copy of the notice to John W. Moran, Supt. No one went with me to the dam. The obstructions in the spillway are the same. There is some leakage at the easterly end of the dam at the toe of slope next the bank. I understand there has always been some. The dam is in good condition and there has been no change. The water level is about 32 by the gauge or about 7 feet below the top.

1932 Report to Co. Comm. The dam forming Haskell's Reservoir south of Essex Ave. is a part of the Gloucester water supply system and is safe and in good condition, except that the waste way is unnecessarily obstructed by bracing, which might unless closely watched retain floating matter and so clog the spillway.

1934, Sept. 28. C. C. Barker, Insp. I gave a copy of the notice to John W. Moran, Supt. The reservoir is in good condition and the same as when last inspected. The obstructions in the spillway still remain. The water level is elev. 23.5 or about 16 feet below the top.

1934 Report to Co. Comm. Haskell Reservoir Dam on Haskell's Brook south of Essex Avenue seems to be in good condition except for obstructions in the spillway which are needless and might lead to serious trouble. This condition was first reported nine years ago and still continues although the cost of removing the hazard would be inconsiderable.

1936 August 12, C.C.Barker, Insp. I left a copy of the notice at the office for John W. Moran, Supt. This dam is in good condition, except there is about the same amount of leakage at the easterly end and there is still some obstruction in the spillway. Water level 28.8 by the guage.

1936 Report to Co. Comm. Little seems to be done in the way of maintenance of the various reservoirs and dams forming a part of the Gloucester water supply. Haskell's reservoir remains as first reported in 1925 with obstructions in the spillway which might cause serious results under conditions reasonably to be expected.

1938 October 26, C.C.Barker, Insp. I gave a copy of the notice to D. R. Bradly, Asst. Super. of the Gloucester Water Works. This dam is in good condition, however there is some leakage at the easterly end and there is a little obstruction, which supports the bridge timber, in the spillway. The water level is 31 feet by the guage.

1938 Report to Co. Comm. It has been noted in past reports that the spillway at Haskell's Reservoir, south of Essex Avenue, was unnecessarily obstructed. Since the last inspection some of the support of the bridge over the spillway have disappeared which to some extent improves conditions. All other obstructions should be removed.

1940, Oct. 4, C.C.Barker, Insp. I gave a copy of the notice to L. E. Hull, Supt. Gloucester Water Works. This reservoir is in good condition. There has not been any change since the last inspection. The water level is 26 feet by the guage.

Gloucester D. 2

1940 Report to Co. Comm. Safe and in reasonably good condition.

1942 Aug. 3, C.C.Barker, Insp. I gave a copy of the notice to L. E. Hull, Supt. of the Gloucester Water Works. This dam is in good condition. However, the leakage at the easterly end is about the same. There are still some timber braces in the spillway which would obstruct the flow somewhat. The water level is 36 feet by the gauge. There has not been any change.

1942 Report to Co. Comm. Haskell's Reservoir Dam is safe and in reasonably good condition, but there are some supports to the bridge over the spillway which should be removed as they obstruct the spillway somewhat.

1944 July 24, S.W.Woodbury, Insp. I gave a copy of the notice to Mr. Hull, who went to the dam with me. The water level is 35.7. No repairs have been made since the last inspection and none are contemplated. Eaving looks good now. Wave action might cut away the bank west of the spillway, but this does not seem probable. It looks quite soggy at toe of slope at easterly end, but I cannot see any water seeping through. There is one tree in the spillway, but no other obstruction now.

1944 Report to Co. Comm. Safe and in reasonably good condition.

1946 Sept. 23, S.W.Woodbury, Insp. I gave a copy of the notice to Mr. Hull and went to dam alone. Water level today is 28.2. Condition of dam is same as previously reported.

1946 Report to Co. Comm. Safe and in reasonably good condition.

1948 Sept. 21, S. W. Woodbury, Insp. Left a copy of the notice for Mr. Hull at his office and went to dam alone. Further inspection is needed to see that stop planks are removed. Water level today: 23.5. There are stop planks across the spillway held solid by the bridge so that the freeboard is about 2 ft. The high water mark shown on the gate house is about 40.0' which shows that the water level this spring must have been held too high for safety.

1948 Report to Co. Comm. Haskell's Reservoir Dam may be considered safe and in reasonably good condition, except that obstructions in the spillway should be removed and the spillway kept clear at all times.

1950 Sept. 19, S.W.Woodbury, Insp. Left a copy of the notice for Mr. Hull at his office and went to dam alone. Water level today: About El. 20. Water is too low. Seepage does not show. Condition of the dam is same as last reported. Spillway is still obstructed.

1950 Report to Co. Comm. At Haskell's Reservoir Dam, the spillway is somewhat obstructed, a condition which should not be allowed. Otherwise, the dam may be considered safe and in reasonably good condition.

D. 2, sn. 4

Gloucester D. 2

1952 Sept. 24, E.H.Page, Insp. Gave a copy of the notice to Mr. Hull at his office at the Water Dept. and went to the dam alone. No visable repairs since last inspection. Water level today: about El. 21.5. Water too low, seepage does not show. Condition of the dam is the same. Spillwa is still obstructed.

1952 Report to Co. Comm. At Haskell's Reservoir Dam, the spillway is still obstructed more or less, a condition which should not exist as this is an important dam, and, if overtopped, serious damage would result. Other wise the dam may be considered safe and in reasonably good condition.

1954 May 19, E.H.Page and J.O.Harmonia, Inps. Water 3" over spillway. Height of flashboards etc. in place: 4-6" planks, not removable. Minimum freeboard with all possible stop logs, etc. in place: 2.1. Obstructions in spillway, sluice, etc.: clear. Slight erosion due to holding water level 3" above slope paving. Condition of dam is good. Spillway 15'-6", minus 3-8" obstructions.

1954 Report to Co. Comm. At Haskell's Reservoir Dam, the spillway still has a three foot eight inch construction. This cuts down the spillway width from fifteen feet six inches to eleven feet ten inches. This is a condition that should not exist on such an important dam, and, if overtopped serious damage would result. Otherwise, dam may be considered safe and in reasonably good condition.

1956 Sept. 13, E.H.Page, Insp. Elev. of water: 22.7 Height of flashboards: 2'-5" 4-8" planks and 1-6" plank. Clear of debris, but see below. It appears that they have added another 6" of flashboards to the spillway. These boards spiked in place. Instead of an opening under the bridge of 13'-8" by 3'-4", it now consists of four openings of 2'-6" by 0'-11". The elevation of top of flashboards is at least 1'-0" above slope paving. Dam shows much erosion due to wave action.

1956 Report to Co. Comm. At Haskell's Reservoir Dam, another six inch plank has been added to the stopplanks which were already eight inches above the slope paving. They are now over one foot higher than the slope paving. This slope paving is put on the face of the dam to protect the earth fill from erosion due to wave action of the water. Now the height of the water is above the slope paving when the reservoir is full and a very serious erosion is taking place. There are some portions of the dam which have been cut back some two or three feet. It is possible that if the water were kept at this height for a period of time, or under certain storm conditions when the reservoir is full, it could result in failure. As these planks are spiked in place and under a bridge, it is very doubtful if they could be removed in a hurry under storm conditions. This dam has been reported over the years as having an obstruction in the spillway. This obstruction consists of three 8" x 8" vertical posts. These posts catch debris as it flows over the spillway and increase the height of the water still more. At least two stopplanks should be removed, the post should be removed, the slope paving should be carried up to the top, and the eroded areas repaired.

1958, Jan. 29, E.H.Page & A.A., Insp. Elev. of water: 31.0 + Water is several feet below the spillway. The flashboards and posts obstructing the spillway have not been removed.

Gloucester D. 2

D 2 Sh. 5

1958, Dec. 30, E.H.Page & K.M.Jackson, Insp. Repairs since last inspection: a 4' 6" slab of conc. (measured on slope) has been placed above the granite slope paving. Elev. of water: 29.7 on gauge. Height of flashboards 2' - 5". Minimum freeboard 18" + Obstructions: Clear. Condition: Good. This new conc. slope paving goes to the top of the slope now and is about 17" + above flashboards. The high water level was some 15" + below top of new conc. paving, but paving is stained (probably from wave action) up to 2" or 3" from top. The flashboards are more or less permanent and would be very difficult to remove at flood stage. The flashboards are same as last reported. Slope paving has settled about half way down the dam in front of gate house.

1958 Report to Co. Comm. At Haskell's Reservoir Dam, the slope has been brought up to the top of the dam with a 4.5 foot concrete slab. The top of this slab is about 1.5 feet above the top of the flashboards. The flashboards are more or less permanent as last reported. They cut down the designed opening of about forty five square feet to about nine square feet, which is broken up into four small openings. The slope paving has settled at a point about half way down the slope in front of the gatehouse. This will bear watching.

1961, Jan. 12, E.H.Page & P.D.Killam, Insp. Condition: Same.

1960 Report to Co. Comm. At Haskell's Reservoir Dam, the flashboards are more or less permanent, as last reported. The designed opening of the spillway has been cut down from about forty five square feet to about nine square feet, which consists of four small openings. The slope paving has settled at a point about half way down the slope in front of the gate house. This will bear watching.

1960 Dec. 17, K.M.Jackson, Insp. Owner: City of Gloucester Water Works. Repairs since last inspection. Bridge has been removed. Granite blocks have been installed as extra stop log (See sketch on Field Report on Dam Inspection). Condition below dam: Good. Elev. of Water: 32' at tower. No leaks. Height of flashboards in place: 2'. No obstructions in spillway. Some of the slope paving in front of gate house, where it had settled in the 1960 report, seemed to have been dislodged. This is under water at present and hard to tell condition. Slope paving should be fixed. Bushes are growing up out of granite slope paving and should be removed before they become trees.

1962 Report to Co. Comm. At Haskell's Reservoir Dam, the designed opening of the spillway had been cut down from about forty five square feet to about nine square feet, which consisted of four small openings. The structure that caused this condition has been removed. In its place a wall has been built in the spillway, consisting of granite blocks 1'0" x 1'5" chinked with burlap and gravel. It is 3'5" high. It is about 12'5" downstream from present flashboards. The slope paving in front of the gate house has settled at a point half way down the slope. Some of the riprap seems to be dislodging and should be fixed. There are also several bushes growing out of riprap that should be removed.

Gloucester D. <

D. 2 Sn. 6

1964 Dec. 29, Paul D. Killam and K.M. Jackson, Insps. Riprap near gate house has been reset as recommended. Obstructions in spillway have been removed and a new set of flashboards installed. Brush removal on both sides of earth dam should continue.

1964 Report to Co. Comm. Haskell's Reservoir. Riprap near gate house has been repaired as recommended. Obstructions in the spillway have been removed and a new set of flashboards installed. Brush removal on both sides of the dam should continue.

1966 April 17, 1967. P.D.K. and K.M.J., Insps. Condition satisfactory.

1966 Report to Co. Comm. Haskell's Reservoir. Brush removal on both sides of the north embankment should be continued.

1966 March 31, 1969. P.Killam and J. Fitzgerald Water level at 36.0 feet and not going through spillway. Brush removal has been completed.

02 —
GLOUCESTER
5-5-107-2

A. E. WILKINSON 7/2/71

ON OUTLET OF HASKELL POND. - BEGIN ON ESSEX AVE. (ROUTE 133)
0.75 MI. EAST OF ESSEX TOWN LINE AT FOREST LANE. TAKE FOREST
LANE SOUTHERLY 0.60 MI. TO DAM.

OWNER - CITY OF GLOUCESTER

USE - WATER SUPPLY

MATERIALS & TYPE - EARTH WITH CONCRETE CORE WALL. POND FACE PAVED
IN CUT SLOPE ON 2:1 SLOPE. DOWNSTREAM FACE SOODED.

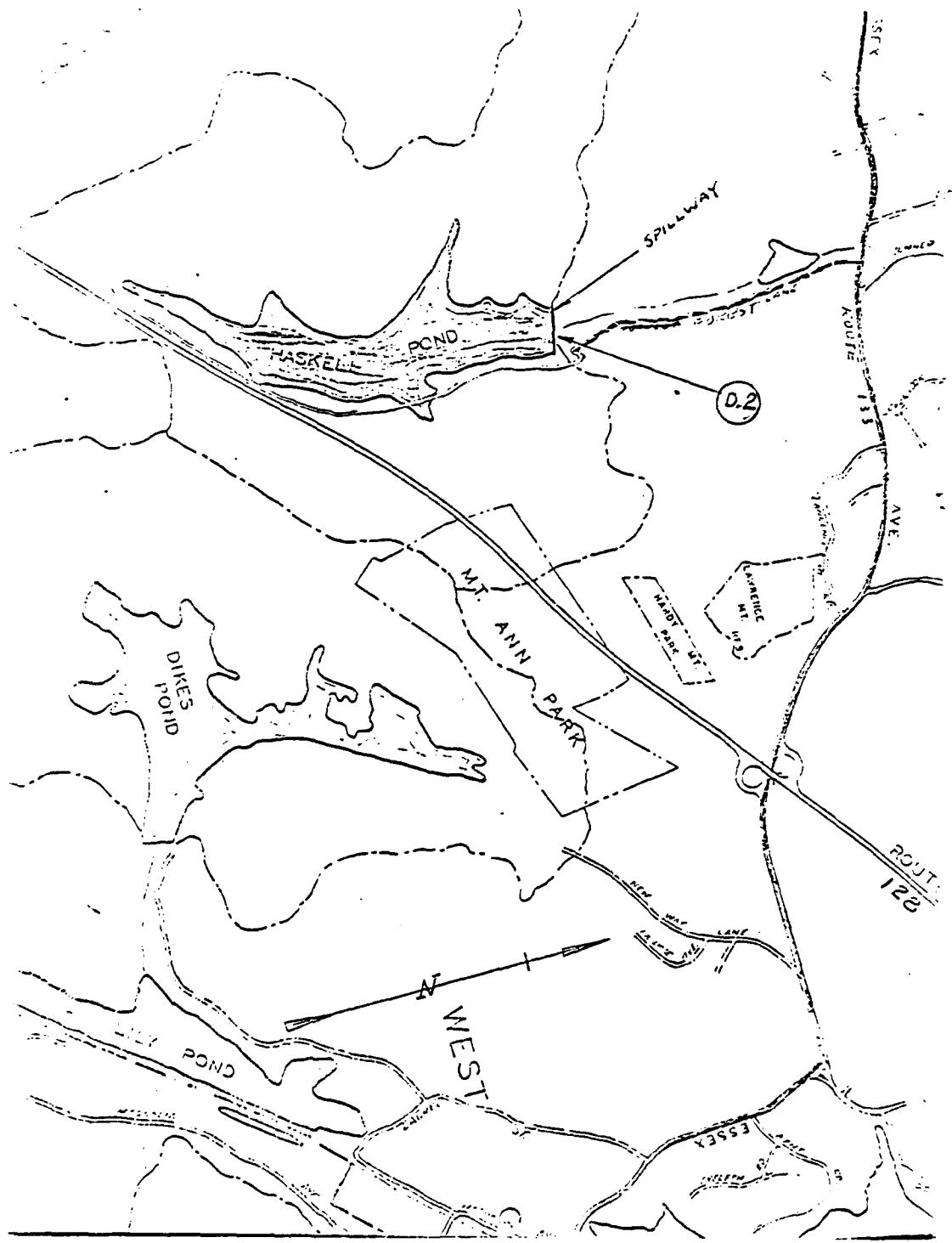
HEIGHT OF DAM - 42.0 FT.

LENGTH - 453.0 FT. ± TOP WIDTH - 18.0 FT. POND AREA - 62.0 ACRES

475,000,000

350.0

DESCRIPTION OF SPILLWAY SPILLWAY 14' WIDE WITH CONCRETE WALLS
WITH MILITARY STONE MASONRY CHANNEL BOTTOM - 3-6" FLASH BOARDS IN
PLACE TO-DAY. FREEBOARD CHANNEL BOTTOM TO TOP OF DAM 5.0 FT NO
WATER IN SPILLWAY TO-DAY. WATER ELEV. 7.0 ± FT. BELOW TOP OF FLASHBOARDS
RECOMMENDATIONS - DAM & SPILLWAY IN VERY GOOD CONDITION.



Engineer's Report.

Gloucester, Mass., December 1, 1903.

To the Board of Water Commissioners of the City of Gloucester:

Gentlemen:—At your request, I submit the following report: Surveys have been made in various localities in which work has been done; the work of constructing the dam and roadways in connection with the Haskell's Brook reservoir is practically completed. Two sections of the delivery main leading from the above named reservoir to the pumping station have been laid, and it is the opinion of the writer that the work of laying the remaining sections should be re-commenced and the work of laying rushed to completion, that the waters in this reservoir may be at the disposal of your Board at the very earliest date practicable. Other details of construction have been acted upon by the writer during the year and plans prepared.

HASKELL'S BROOK RESERVOIR.

Construction.

The construction of the dam was continued until Dec. 5, 1902, all work being practically suspended on this date because of a severe storm and continued disagreeable weather. The valves on the outlets were closed Dec. 16th, and the waters retained to a depth of thirteen and seventeen hundredths feet. As the paving on the southerly slope was not completed to a sufficient height to allow for the storing of water at a greater depth, the valves were opened on January 28th, 1903, and the waters allowed to pass through the gate chamber and delivery main to the brook-bed below the structure.

On March 24th, the contractor re-commenced operations under the personal supervision of the writer, opening a borrow pit on the east side of the valley, north of the site of the work and between the lower and upper entrances to the premises.

The surface of the waters at this time being a few inches above the finished work on the paved slope, the blow-off was opened and sufficient water withdrawn to allow the pavers to proceed. The outlets



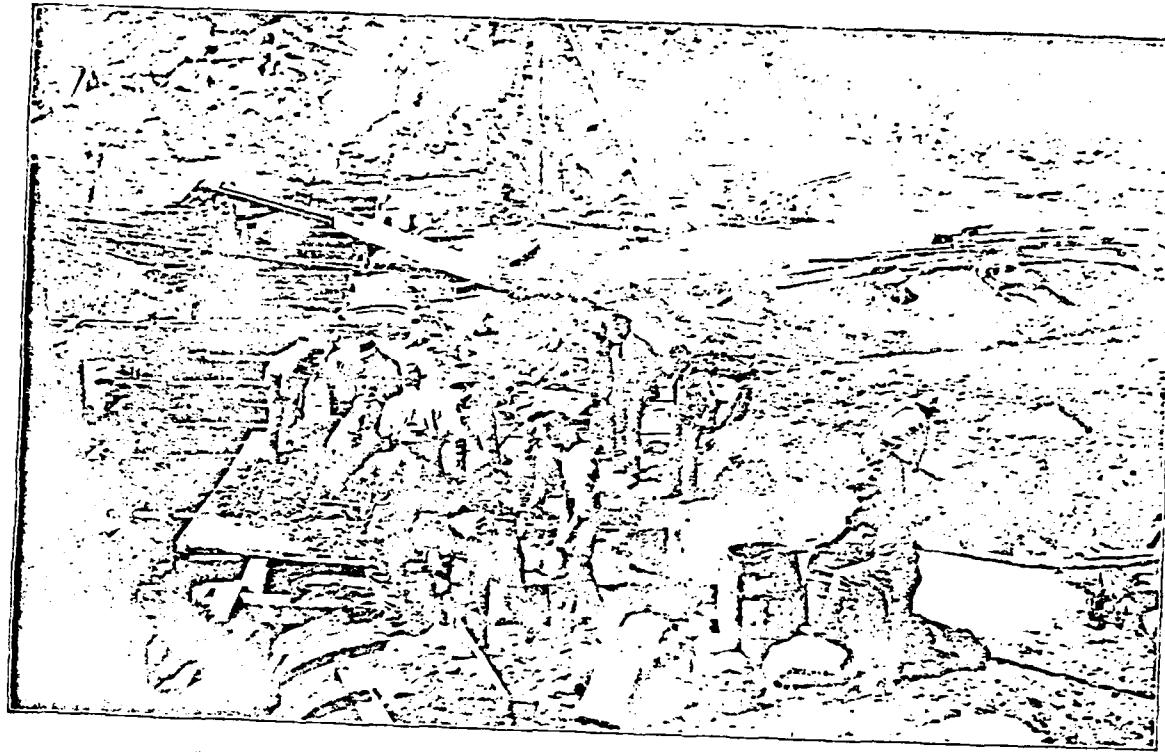
View of Haskell Pond (Surface at Grade 31.21) Looking Southward from Top of 'Sugar Loaf' Near the Original Dam — Sept. 9, 1901

were closed on March 30th, and have since remained closed, except on June 22, after a heavy rainfall, when the depth of water increased rapidly and interfered with the placing of the plaster finish on the outside of the Gate chamber.

On May 10th, your Board visited the work and after considering the appearance and durability of the finish on the exposed surface of the Gate Chamber, decided that a cement coating should be used over the entire surface, eliminating the granolithic finish mentioned in the contract.

The cements delivered upon the work by the contractor during this year were of the following brands of Portland cement: American, Alsen, Northampton and Atlas. All brands of cements delivered and stored upon the works, were treated as during the season of 1902, samples being taken as the different lots arrived upon the works, which were then forwarded to Mr. Nelson A. Hallett for testing. All reports received from the tester indicated that the cements tested were of a quality permissible under the terms of the contract for use on this work, until a report was received on samples numbered from 71 to 80 inclusive. These samples were taken from a delivery of a brand of Portland cement in bags labelled "Northampton," the date of obtaining the samples being April 29, 1903, the cement having arrived on April 28th. This report indicated a decided falling off in the quality of the brand mentioned, and a second lot of samples were taken, as this brand had been above the required standard during the previous season. The second report indicated the same inferior quality, the test showing that this lot was far below the required standard, and the cement was condemned, being removed from the works by the contractor. As the concrete work on walls which were not to be left exposed to the action of the weather when the work was completed was well advanced toward completion, the writer suggested, in the letter condoning the cement, the procuring of other brands which had been tested and used previously in the work.

On May 13th, and while the above mentioned cement was being removed from the work, a representative of the agent through whom the contractors procured the cement, or of the manufacturer, called at the works and after a casual examination of the reports of tests and of the cement, requested that another test be made at his expense. This was done, five samples numbered from 116 to 120 inclusive being shipped to Mr. Hallett and another five, numbered from 111 to 115 inclusive, were sent to Booth, Barrett and Black of Philadelphia,



View Looking Westward, Showing Concrete Wall, Trench Braced and First Work in Concrete.—Sept. 11, 1902

19. A report upon the lot of samples sent to Mr. Hallett was received, showing that the inferior quality as was previously shown by the reports of tests was still evident, but up to this time the writer has not seen the results of the tests made of the latter shipment of samples numbered from 111 to 115 inclusive.

The concretemen cement was replaced by other brands of cement which passed the required test. All brands of cements, including At-tac, Heleberg, Dregon, American Alsen and Northampton, delivered upon these works which passed inspection were used, no cement being condemned except such of the brand of Northampton as was received on the works during this season.

The work of clearing and grading the large excavations was commenced on June 17, the large boulders were broken, moved to the base of the northerly slope of the dam and under the steep banks of the pit, covered with gravel and taun and otherwise disposed of. The completing of the work progressed slowly, the core wall being completed July 1st, the macadam roadway, bridge and superstructure, grading and sealing, being practically completed on August 4th.

The temporary buildings occupied by the laborers were removed and refuse cleared away, the contractor leaving the premises on August 8th.

Credit is due the contractors, Messrs. Coleman Bros. of Everett, Mass., inasmuch as they succeeded in completing the work without serious accident and had no trouble of any consequence with the labor employed, and that they completed the work, with the exception of a few days, within the time mentioned for completion. Credit is also due to Mr. John Henderson, he having done, in the opinion of the writer, creditable work, inasmuch as it was under his personal supervision for the contractor during the most trying stages of the work that the contractors succeeded in completing the structure on August 8th, and that without serious accident.

The employees of this department, working under the direction of the writer and connected with this work were Messrs. Addison G. Standwood, Edward Marsh, Charles S. Merchant and Frank Miller, all residents of Gloucester, they having performed such services as were required of them with credit both to themselves and to this department.

Your Board visited the premises for the purpose of final inspection and at a meeting on the same day, August 13th, voted to accept the work.

The final estimate was submitted to your Board and the contractors filed bills for extra compensation which are now before you for consideration.

The depth of water at the gate chamber on December 1st was 20.17 feet, the reservoir containing on this date 167,187,900 gallons.

The dimensions of the reservoir are as follows:

The capacity of the upper fifteen feet (normal) is 236,510,450 gallons and the total amount contained above Grade 11.5, viz.: 245,023,7250 gallons, may be transferred at will to the pumping station by gravity. This reservoir, however, should not be drawn below grade 90.5 unless there is extreme necessity.

The area of this reservoir, when filled to the normal draw line at grade 11.5 is 56.82 acres, the average being increased to 62.41 acres by the use of flashboards, the surface to grade 114.0.

The average depth at the normal elevation is 23.06 feet, the entire contents and area being considered. When, however, the area of the bottom of the reservoir proper, 26.5 acres, is considered separately, the average depth over the entire latter area is 31.75 feet.

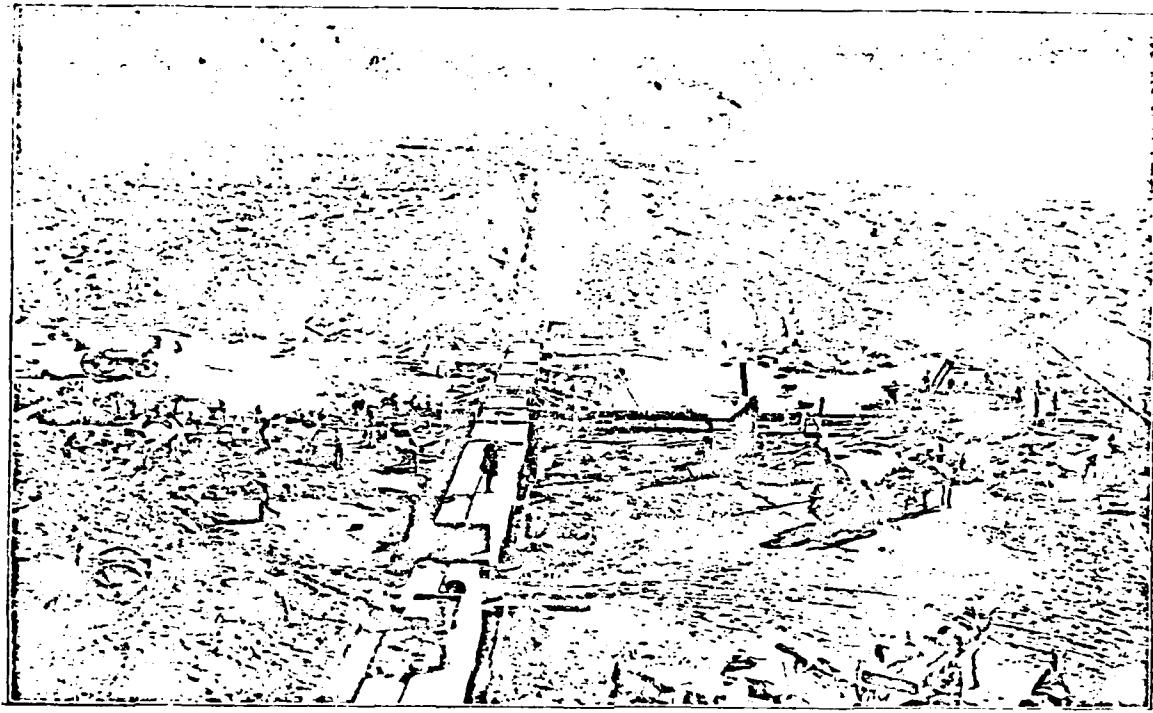
When flashboards are in use and the depth of water increased above normal depth to grade 114, 48,527,425 gallons are added to the normal amount, making a total of 475,489,885 gallons which it is possible to store within the Haskell's Brook reservoir.

The following figures are given for comparison:

Reservoir.	Area (Normal) Acres	Area (Normal) Feet.	Contents Gallons	Reservoir Depth Feet	Date
Dikes Meadow	57.57	12.57	236,900,000	23.40	1900
Wallace Brook	24.16	7.98	63,000,000	17.10	1900
Haskell's Brook	56.82	23.06	426,962,450	37.00	1901

(Capacity of Wallace Brook and Dikes Meadow reservoirs have

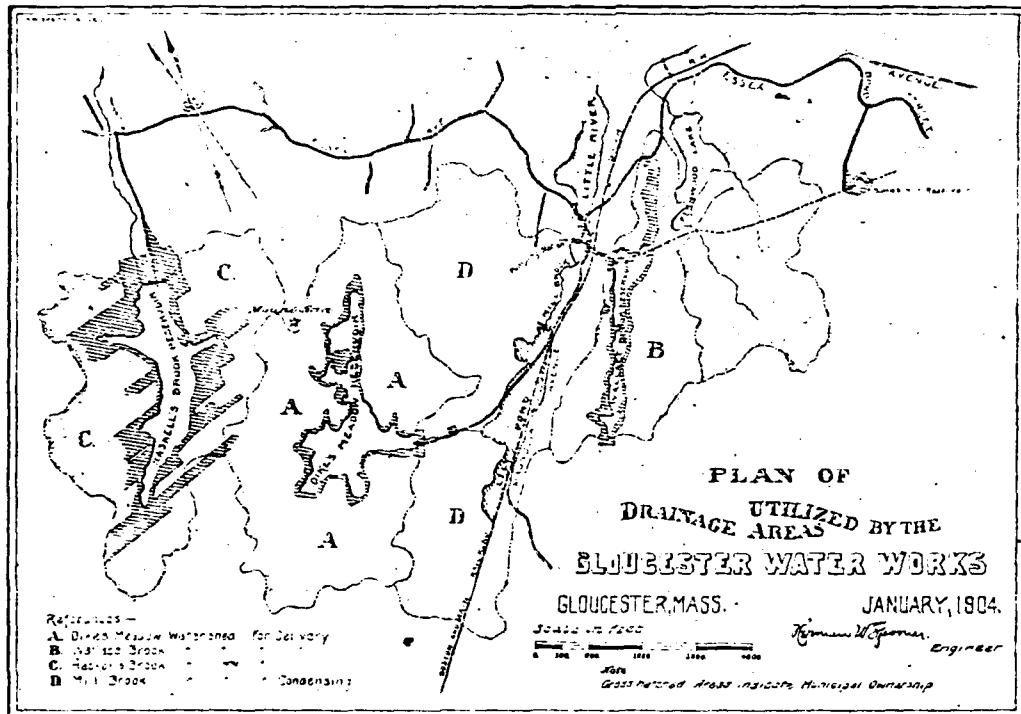
been slightly increased since 1900.)



View Looking Easterly, Showing Concrete Core, Twenty-inch Delivery Main and the Lining of the Gate Chamber Commenced.—Oct. 10, 1902.



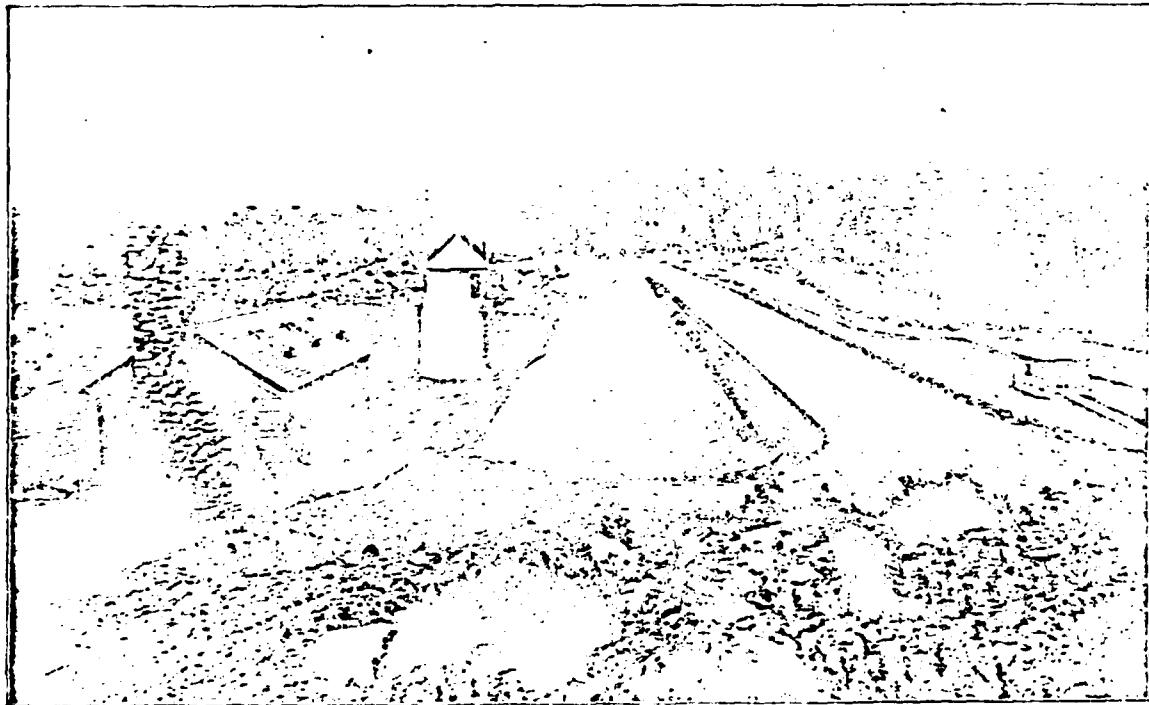
View of Work in the Gate Chamber, Showing the Block Wall, Concrete Core, and Block Lining, in the Gate Chamber, Oct. 10, 1902.

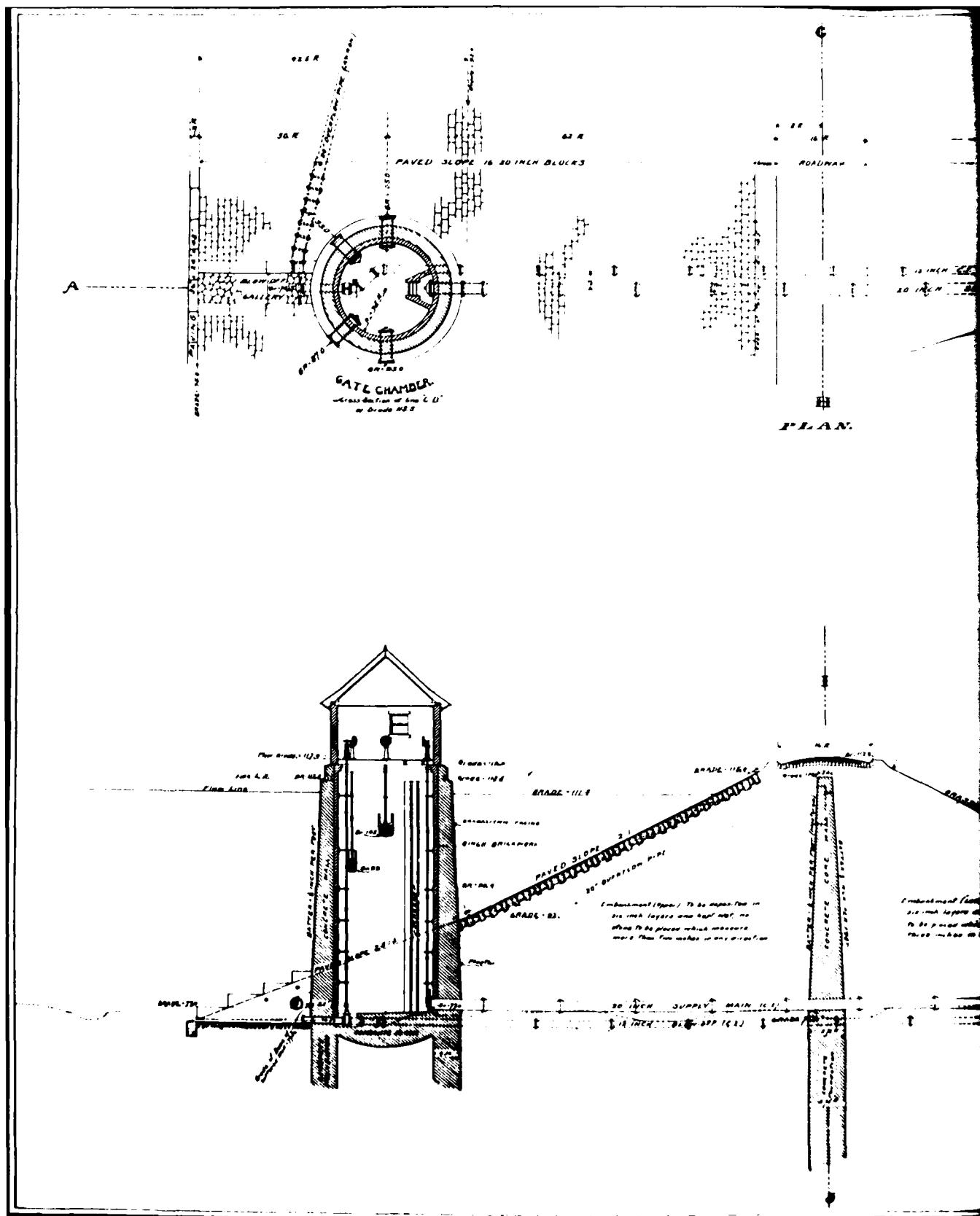


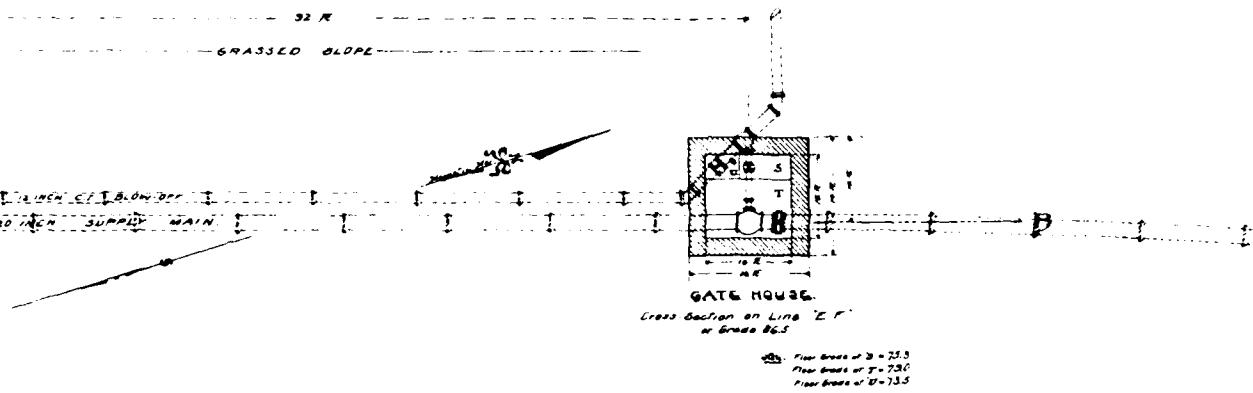
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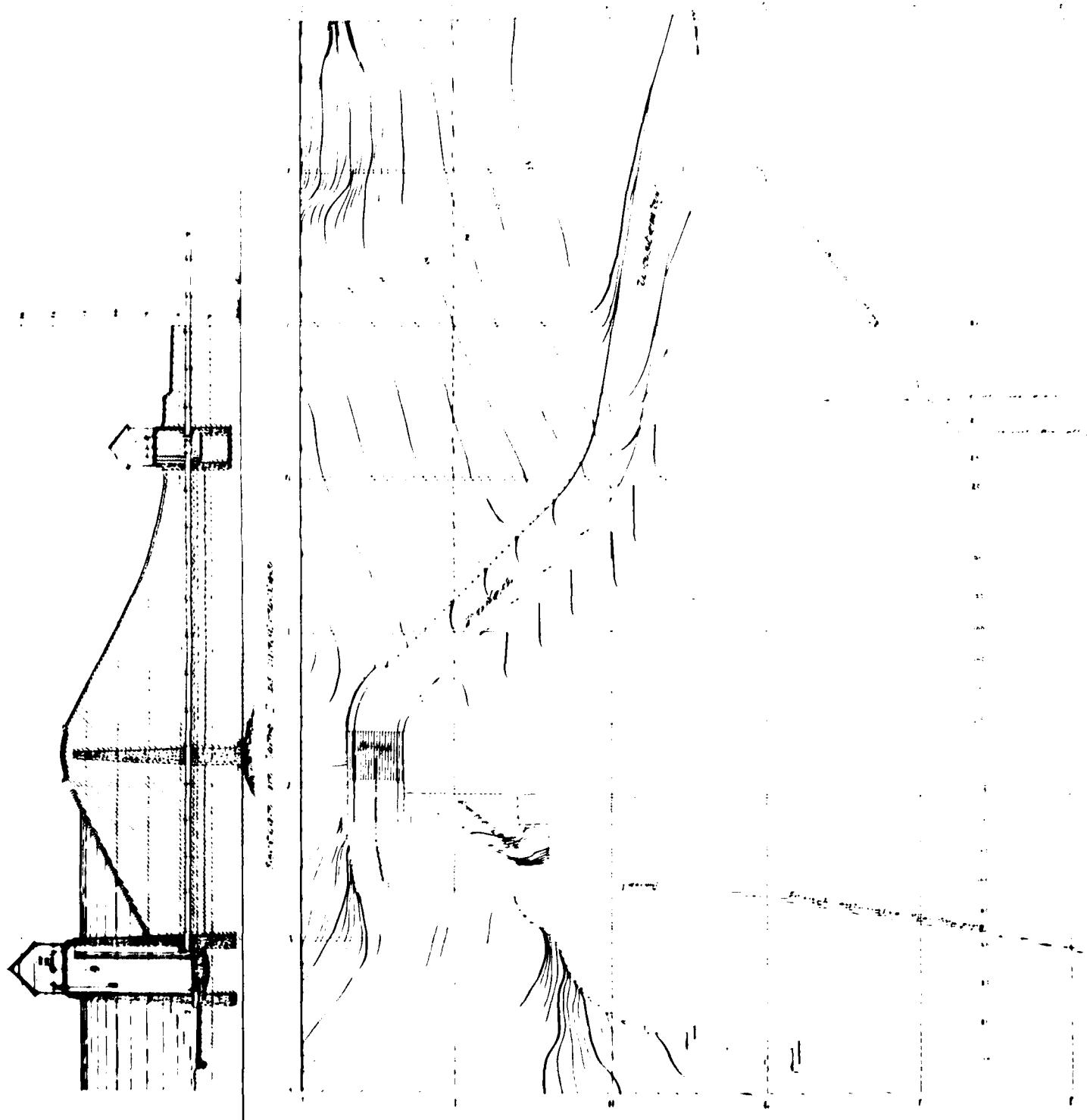


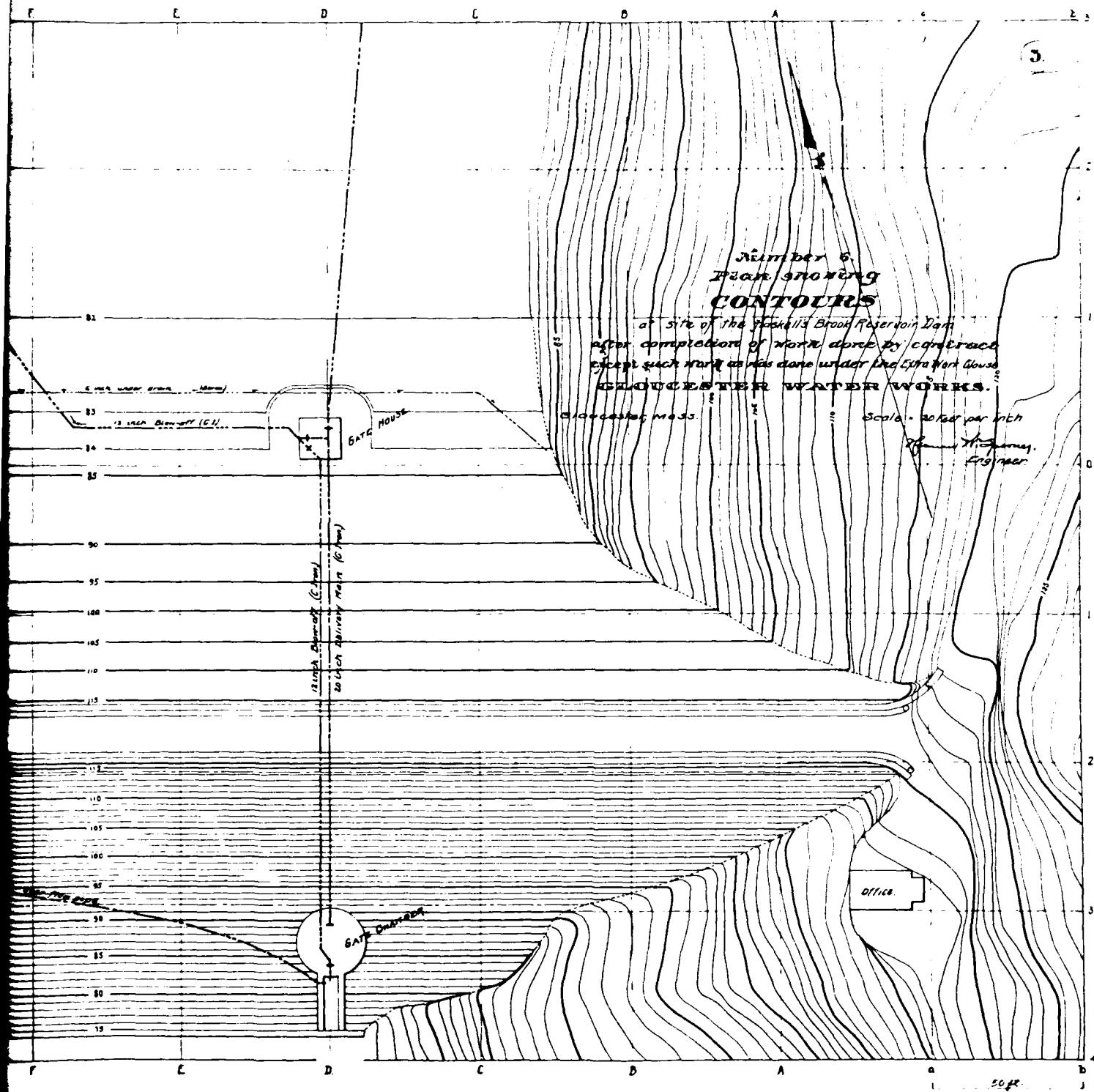
Plan No. 2.
Showing
Plan and Cross-Section
of a proposed
Dam and Appurtenances
on the line of
Haskell's Brook.
GLoucester Water Works.
Gloucester, Mass. May 20, 1902
Scale - 6' 6 1/2" per inch.

Loren X. Spurr,
engineer

Embankment (inner) to be deposited in
six inch layers and held fast by stones
to be placed which measure more than
three inches in any direction.

Cross-Section on Line A.D.



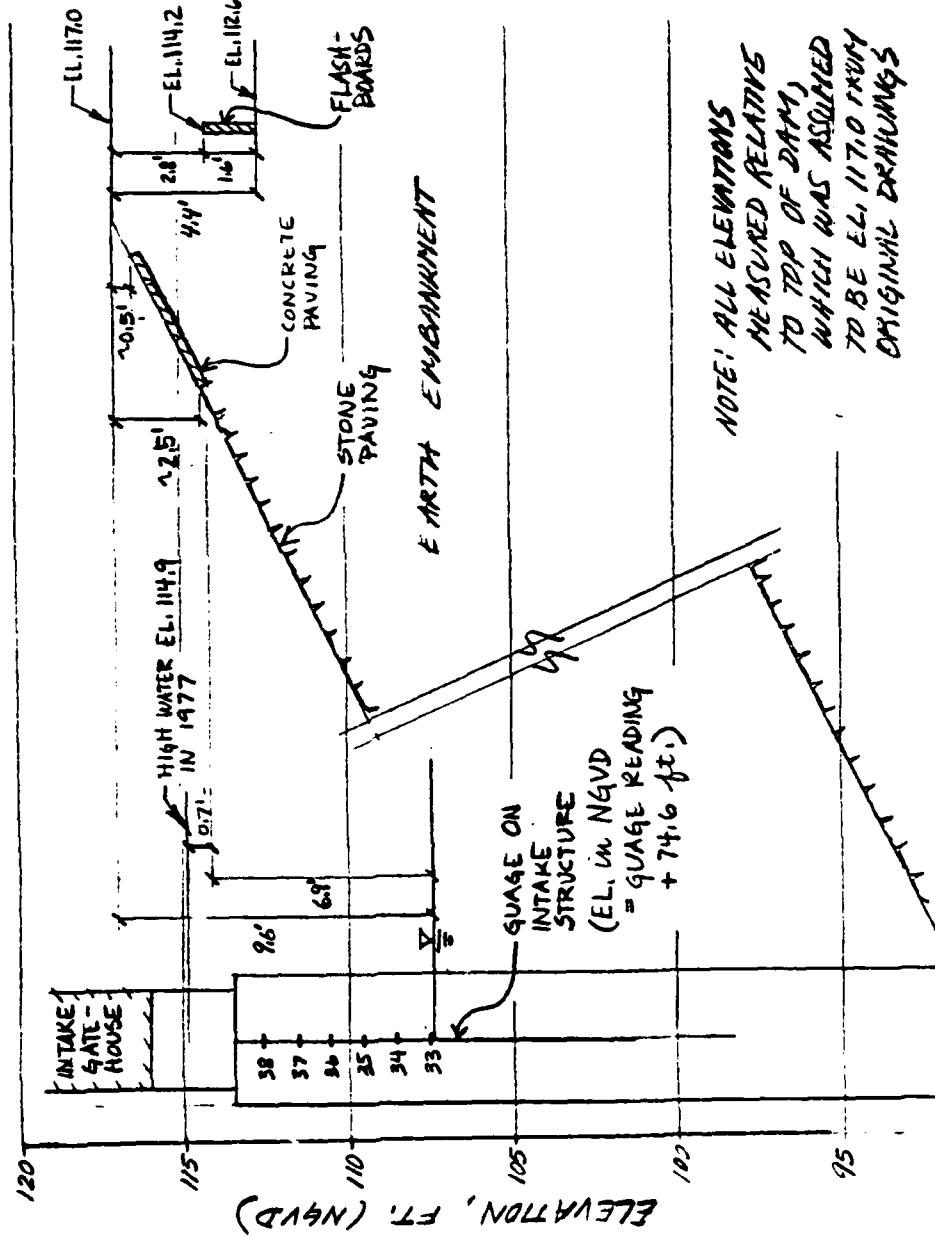


HALEY & ALDRICH, INC.
CAMBRIDGE, MASSACHUSETTS

PROJECT Haskell Pond Dam
Field Sketch with Assumed Elevations

PROJECT Haskell Power Dam
Field Sketch with Assumed Elevations

FILE NUMBER 4270
SHEET 1 OF 1
DATE 21 August 1974
COMPUTED BY R. B. B. B.
CHECKED BY _____

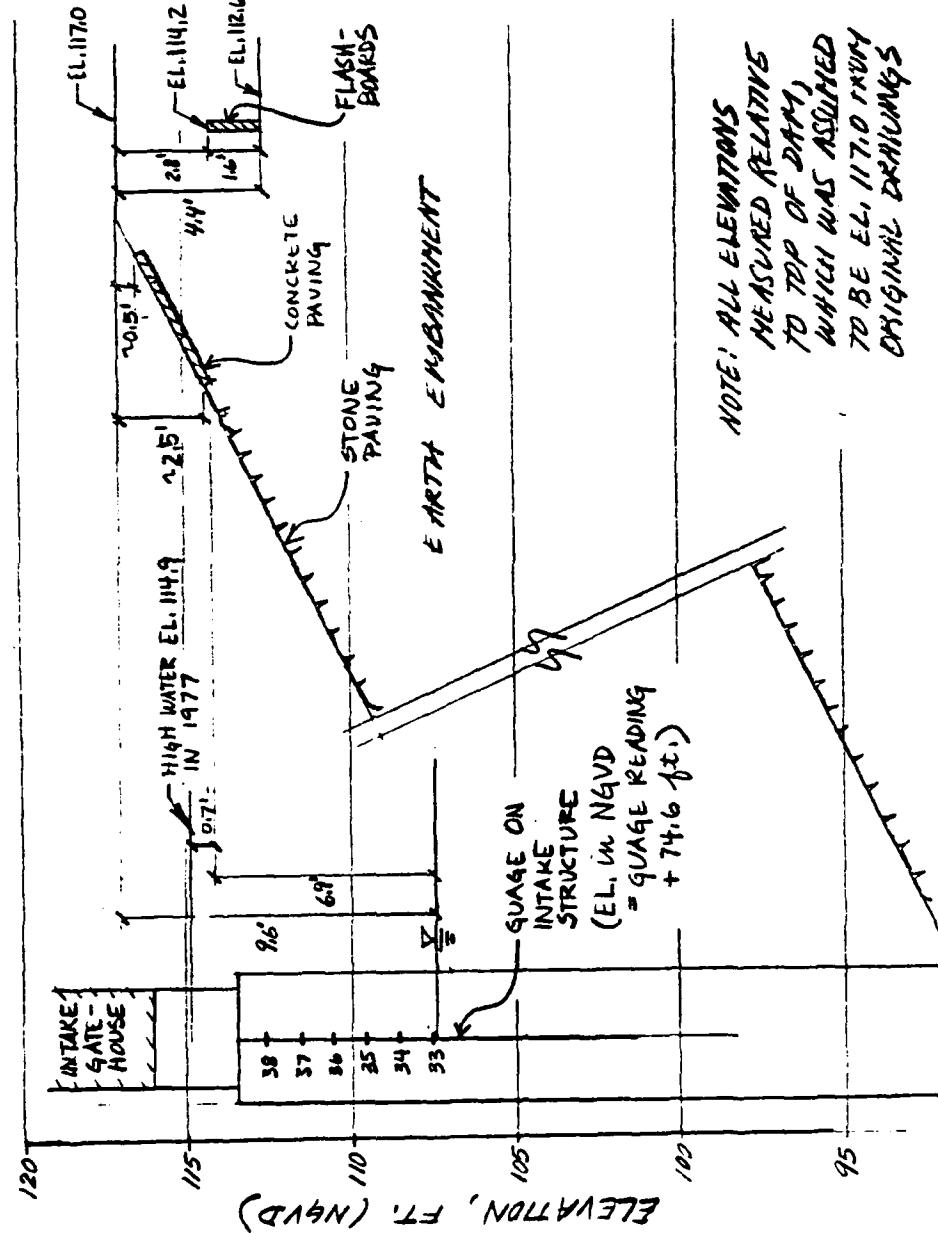


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HALEY & ALDRICH, INC.
CAMBRIDGE, MASSACHUSETTS

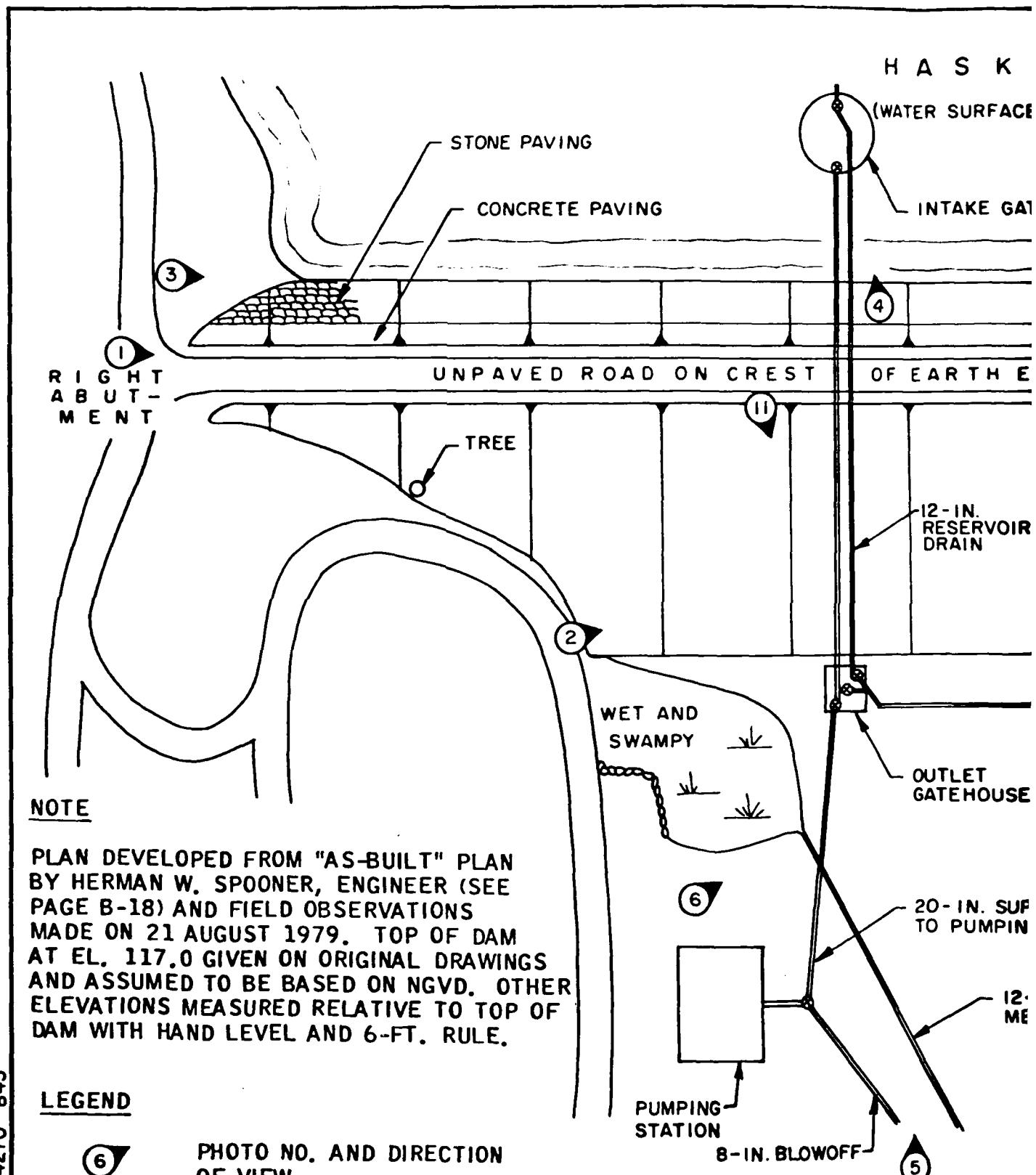
CLIENT NED CORPS OF ENGI.
PROJECT HASKELL RIVER DAM
Field Sketch with Assumed Elevations

FILE NUMBER 4270
SHEET 1 OF 1
DATE 21 August 1979
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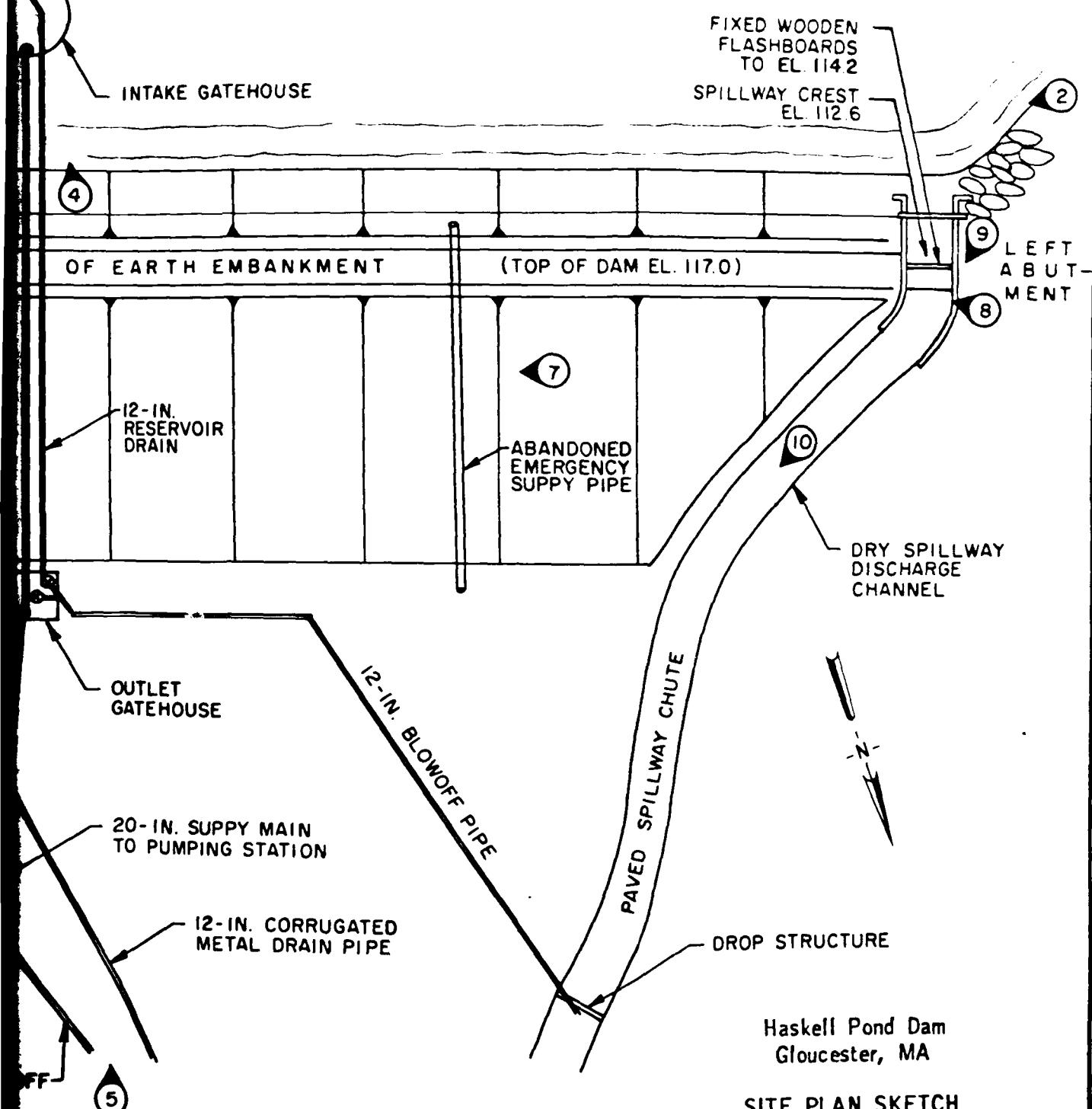
APPENDIX C - PHOTOGRAPHS

			<u>Page</u>	
<u>LOCATION PLAN</u>				
	Site Plan Sketch		C-1	
<u>PHOTOGRAPHS</u>				
<u>No.</u>	<u>Title</u>	<u>Roll</u>	<u>Frame</u>	<u>Page</u>
1.	Overview of Haskell Pond Dam	C43	22	vi
2.	Upstream side from left of dam	C44	5	C-2
3.	Upstream side of dam from right abutment	C43	23	C-2
4.	Circular intake structure with reservoir level gauge	19	21	C-3
5.	Downstream side of dam	C43	19	C-3
6.	Downstream face of embankment, left side	19	13	C-4
7.	Downstream face of embankment, right side	19	12	C-4
8.	Spillway weir and approach channel	C44	2	C-5
9.	Spillway weir and discharge channel	C44	3	C-5
10.	Paved trapezoidal spillway chute	C44	10	C-6
11.	Outlet gatehouse, pumping station and wet, swampy area at downstream toe of dam	C44	1	C-6



HASKELL POND

(WATER SURFACE EL. 107.4 ON 21 AUGUST 1979)



Approx. Scale: 1" = 40' September 1979

C-1



2. Upstream side from left of dam



3. Upstream side of dam from right abutment



4. Circular intake structure with reservoir level gauge



5. Downstream side of dam



6. Downstream face of embankment, left side



7. Downstream face of embankment, right side



8. Spillway weir and approach channel



9. Spillway weir and discharge channel



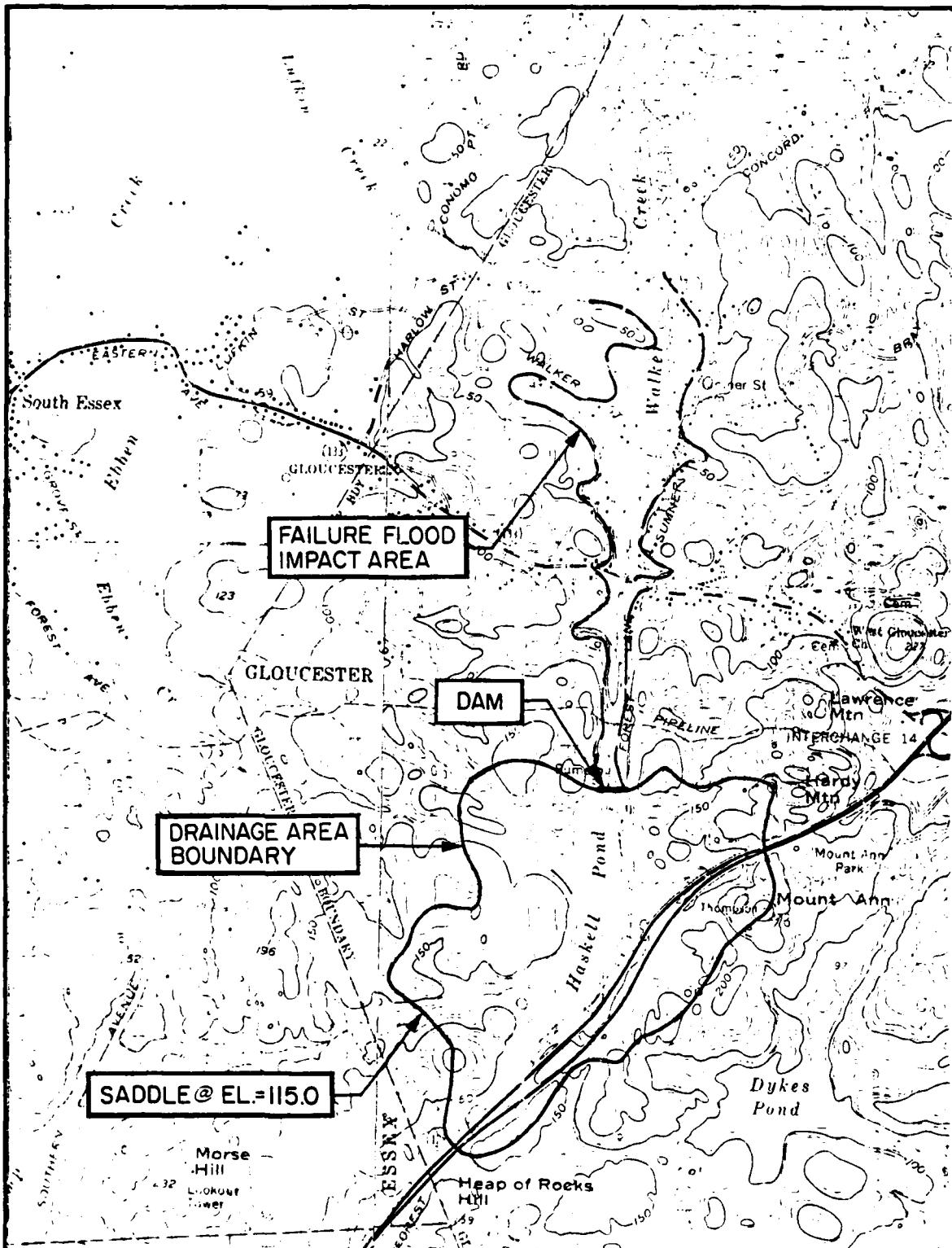
10. Paved trapezoidal spillway chute



11. Outlet gatehouse, pumping station and wet, swampy area at downstream toe of dam

APPENDIX D - HYDROLOGIC AND HYDRAULIC COMPUTATIONS

<u>SUBJECT</u>	<u>PAGE</u>
Drainage Area and Failure Flood Impact Area Map	D-1
Size Classification, Hazard Potential and Test Flood Development	D-2
Surcharge-Storage Routing	D-3
Pond Stage - Discharge Curve for Condition 1	D-4
Reservoir Area-Volume Curve	D-5
Pond Stage-Discharge Curve for Condition 2	D-6
Tail Water; Capacity of Existing Spillway, Conclusion	D-7
Dam Failure Analysis	D-8
Failure Flood Hydraulic Profile	D-11
Failure Flood Impact - Summary Table	D-12
Downstream Channel Cross Sections and Stage-Discharge Relations	D-13



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CLIENT HVA PROJECT COF Dam Inspection DETAIL Haskell Pond Dam

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Size classification

Dam Height : $(Els : 117 - 74 =) = 43 \text{ Ft.} > 40 \text{ FT}$

Storage Volume : $1,800 \text{ Acre-ft} @ El. = 117.0 > 1000 \text{ ac-ft}$

Size : Intermediate

Hazard Potential Classification

If the dam were to fail the following properties would be seriously flooded: a water supply pump station; State Highway Route 133; about 20 dwellings (residential) along and in the flood plain of the Walker Creek. (A detailed list of failure flood impact is shown in Page D-12). The hazard potential is considered to be "high" because of potential for loss of lives and economic loss to public and private property.

Test Flood Development

Size : Intermediate ; Hazard Potential : High.
Test Flood Flow: PMF

Watershed Area : $0.63 \text{ sq mi} = (403 \text{ acres})$

Terrain : Rolling coastal with 15% flat

Peak Flow Rate : $1,075 + 0.15 + 0.85 \cdot 2450 = 2,240 \text{ cfs/sq mi}$

$PMF = 0.63 \times 2,240 = 1,400 \text{ cfs. (Spillway Test Flood Inflow)}$

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Surcharge - Storage Routing

$$Q_{P_1} = 1400 \text{ cfs} \quad (\text{PMF} \rightarrow 15" \text{ max. runoff})$$

Condition 1 : The existing 1.6 Ft stoplogs are left in place ;
Spillway crest el. 114.2

WSE @ the Pond : 117.80 for Q_{P_1} ; see Stage-Discharge curve, page D-4.

Volume : 1,840 ac-ft @ El. 117.8 ; see area-volume curve, page D-5

Normal pond volume : 1,520 ac-ft @ El. 112.6 (assumed)

Surcharge Volume = 320 ac-ft

$$\text{STOR 1} = \frac{320 \times 12}{403} = 9.53" \quad Q_{P_2} = 1400 \left(1 - \frac{9.53}{19}\right) = 700 \text{ cfs} \quad \left\{ \begin{array}{l} \text{WSE} = 117.33 \\ \text{Vol.} = 1820 \end{array} \right.$$

$$\text{STOR 2} = \frac{1820 - 1520 \times 12}{403} = 8.93" \quad \text{STOR}_{\text{av}} = 9.23"$$

$$Q_{P_2} = 1400 \left(1 - \frac{9.23}{19}\right) = 720 \text{ cfs.} \rightarrow \text{WSE} = 117.35 \quad \text{Vol.} = 1830$$

$$\text{STOR}_3 = 9.23" = \text{STOR}_{\text{av}}$$

$$\text{Test Flood Outflow : } 720 \text{ cfs} \quad \text{WSE} = 117.35 > 117.0$$

About 290 cfs of the total would flow over the spillway, 230 cfs over the embankment and banks, and the remaining 200 cfs would be naturally diverted into Cedar Swamp.

Condition 2 : No stoplogs at the spillway Crest (El. 112.7)

$Q_{P_1} = 1,400 \text{ cfs} \rightarrow \text{WSE} = 117.68$; See Stage-Discharge Curve, Pp. D-6

$$\text{Volume} = 1,830 \quad \Delta V = 310 \text{ ac-ft.} \quad \text{STOR 1} = \frac{310 \times 12}{403} = 9.23"$$

$$Q_{P_2} = 1,400 \left(1 - \frac{9.23}{19}\right) = 720 \text{ cfs.} \quad \text{WSE} = 117.19 \quad \text{Volume} = 1810 \text{ ac-ft}$$

$$\text{STOR 2} = \frac{290 \times 12}{403} = 8.64" \quad \text{STOR}_{\text{av}} = 8.94"$$

$$Q_{P_3} = 1,400 \left(1 - \frac{8.94}{19}\right) = 742 \text{ cfs.} \rightarrow \text{WSE} \approx 117.17 \quad \text{Vol.} \approx 1810 \text{ ac-ft}$$

$$\text{Test Flood Outflow : } \approx 740 \text{ cfs.} @ \text{WSE} = 117.17$$

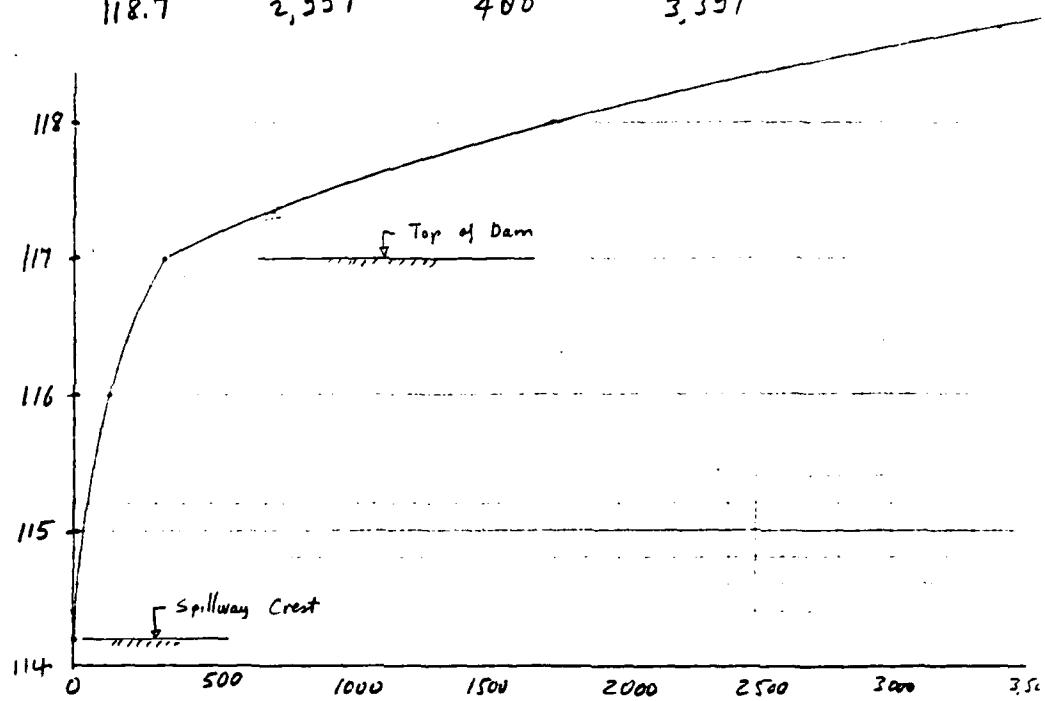
Out of this total about 470 cfs would flow over the spillway 110 cfs over the dam embankment and 160 cfs over the saddle.

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Stage - Discharge Relation for total outflows
From Haskell Pond Reservoir

Condition 1 : 1.6 FT high stoplogs in place

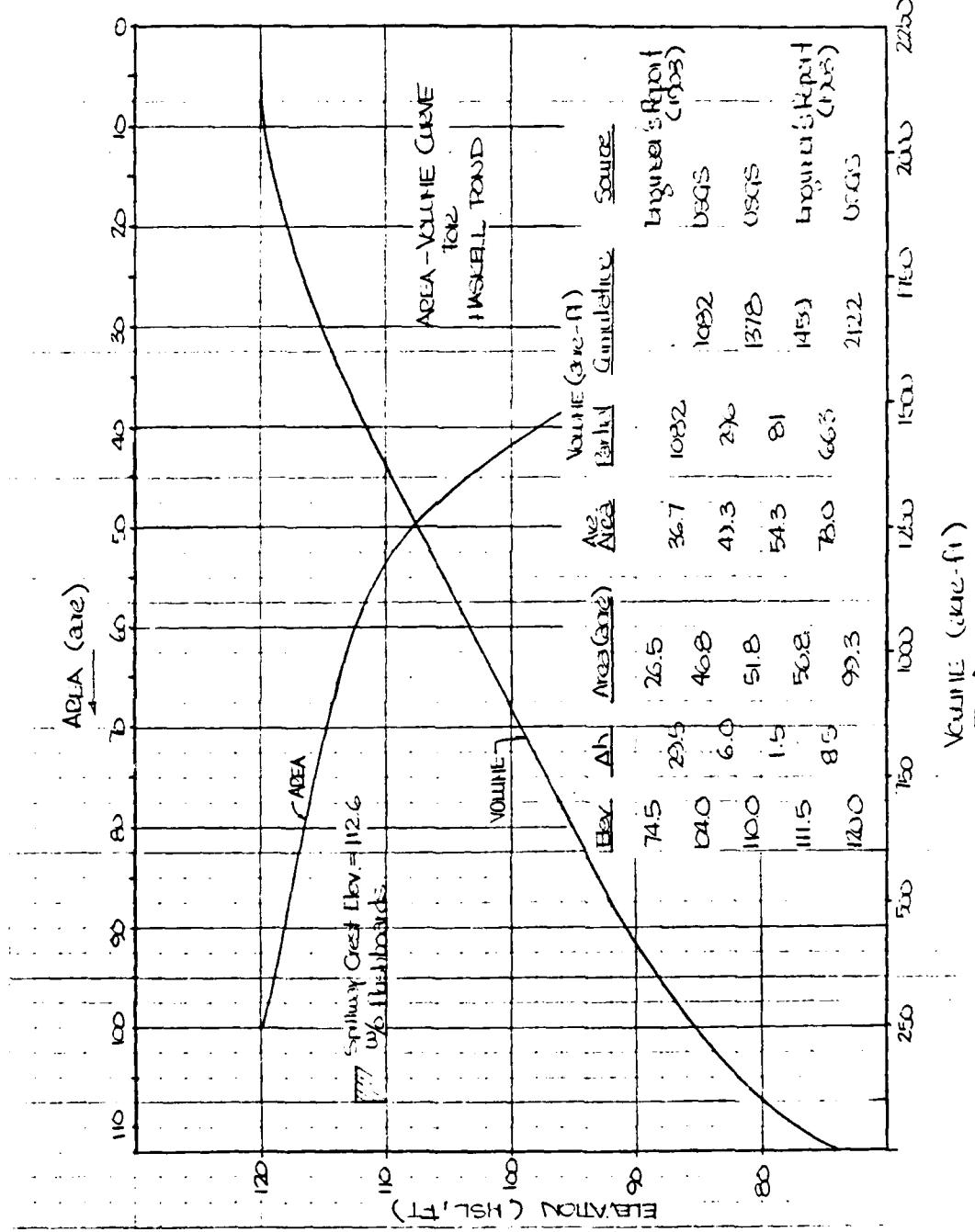
E1.	Discharges (cfs)		
	Over Spillway + Dam	Over Saddle	Total
115	34	0	34
116	113	13	126
117	220	98	318
118	1,483	257	1,740
118.7	2,957	400	3,397



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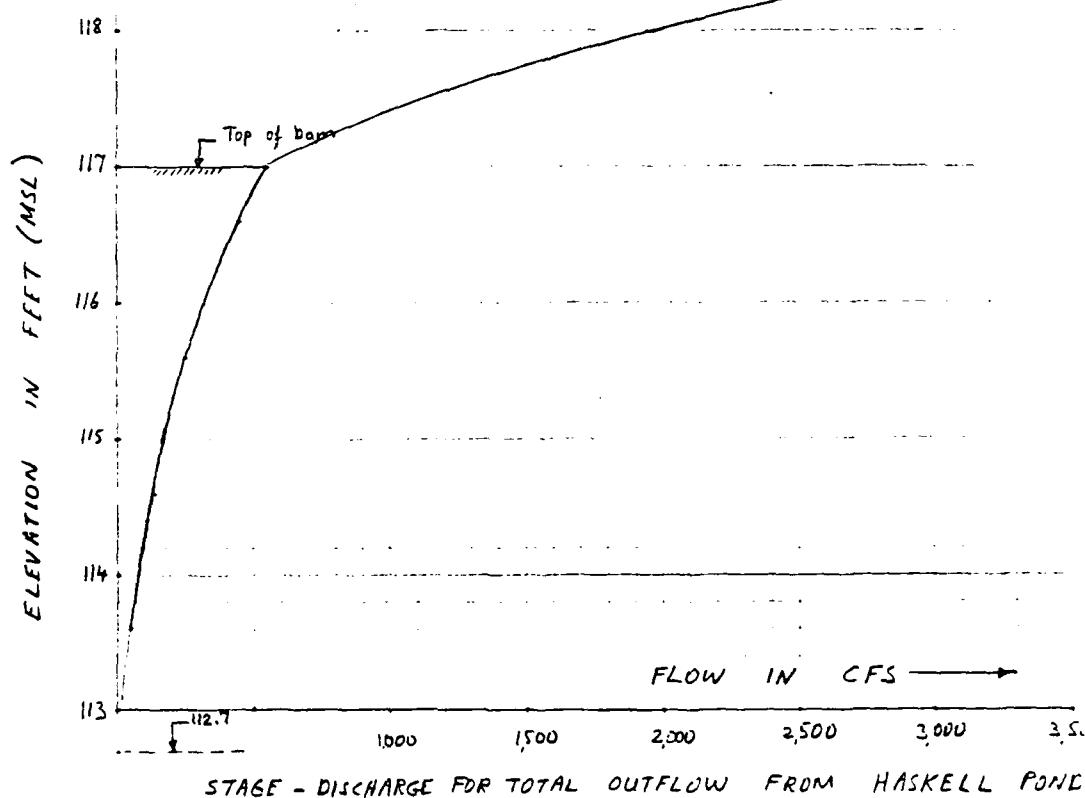
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Condition 2 : w/o stoplogs

E.L.	Discharges (cfs)		
	over Spillway	Over Saddle	Total
113.6	47	0	47
114.6	133	0	133
115.0	170	0	170
115.6	244	7	251
116.6	375	65	440
117.0	433	98	531
118.0	1,724	257	1,981
118.6	3,017	360	3,377

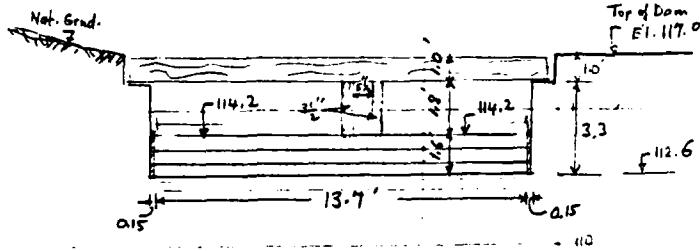


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Tail Water . The tailwater stage-discharge curve on page b-8 shows that the spillway crest would not be submerged at the test flood discharge.

Capacity of Existing Spillway

a) With Stop-Logs : $Q = 3.5 L \frac{2.8}{3/2} = 225 \text{ cfs}$.
 Flow over the saddle @ El. 117.0 = $\frac{100}{325} \text{ cfs}$
 Total Outflow From Reservoir: 325 cfs
 $325 / 720 = 0.45$ Outflow capacity is 45% of the test flood.



b) Without Stop-Logs :

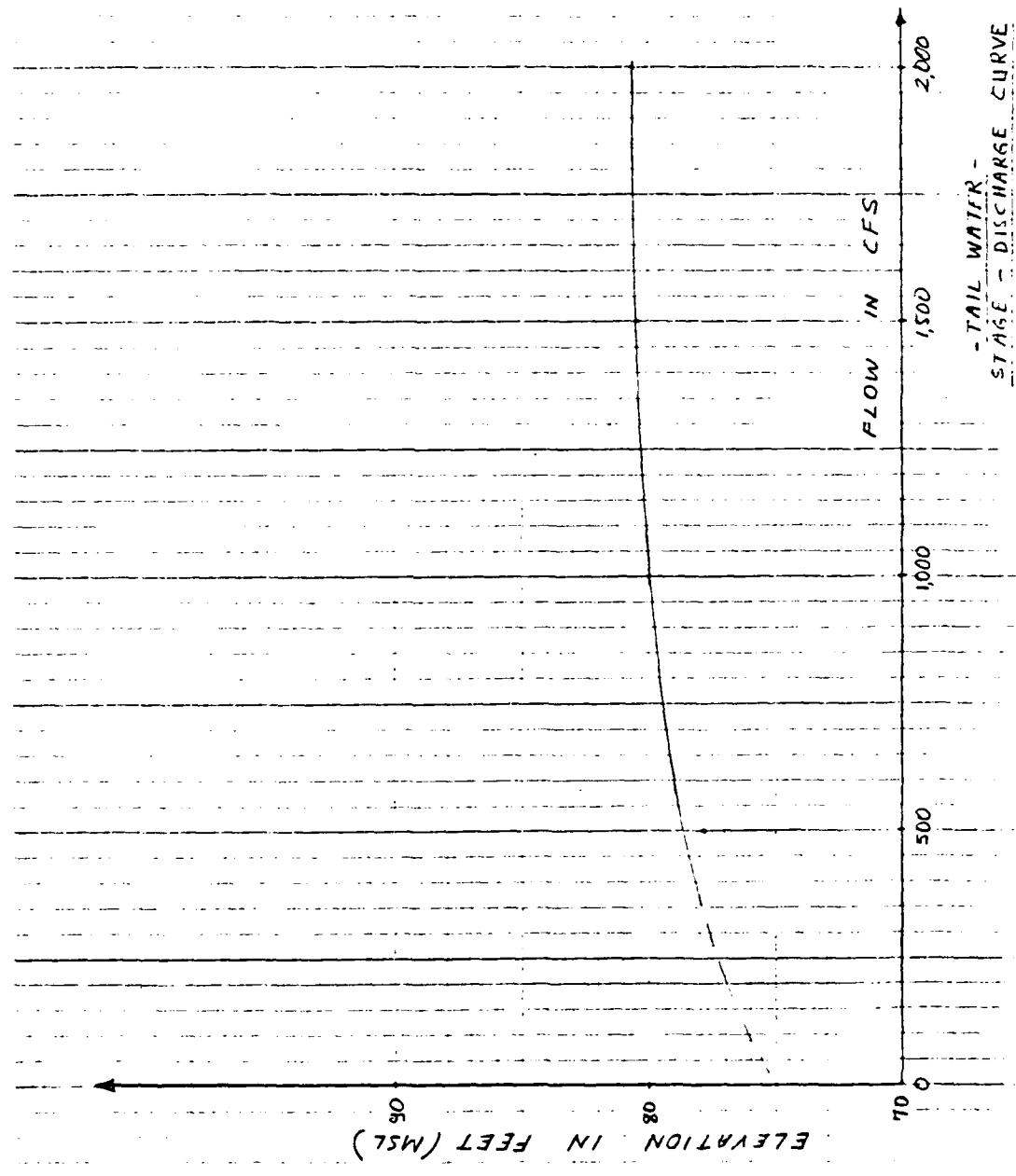
$Q = 3.5 L \frac{4.4}{3/2} = 435 \text{ cfs}$.
 Flow over the saddle = $\frac{100}{535} \text{ cfs}$
 Total Outflow from Reservoir: 535 cfs

$535 / 720 = 0.72$ Outflow capacity is 72% of the test flood.

Conclusion : Capacity of existing spillway, in combination with the natural diversion over the saddle, can be increased from 45% to 72% of the test flood outflow by removal of the stop-logs.

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Dam Failure Analysis

$$\text{Peak Failure Flood: } Q_{P_1} = \frac{8}{27} W_b \sqrt{g} Y_0^{3/2} \quad W_b = 0.4 \times 450 = 180'$$

$$Y_0 = 43'$$

$$Q_{P_1} = \frac{8}{27} (180) (5.67) (281.9) = 85,267 \approx 85,300 \text{ cfs.}$$

$$\text{Flow prior to failure: } \text{WSE} = 117.0$$

$$\text{Max. Flow Prior to failure (assume no stoplogs)}: \approx 400 \text{ cfs.} \quad (\text{Page D-7})$$

Hydraulic Profile after the failure is shown on Page D-11.

Max. Storage in the pond prior to failure: $s_i = 1800 \text{ ac-ft.}$
 $\text{@ E.I. } 117.0$

Routing of Failure Flood Flow

Reach 1 : (Between Dam and Rt. 133) :

$$V_1 = \frac{16,200 \text{ sft} + 7,200 \text{ sft}}{2} \cdot 3000 \cdot \frac{1}{43560} = 805 \text{ ac-ft.}$$

$$Q_{P_2} (\text{trial}) = 85,300 \left(1 - \frac{805}{1800}\right) = 47,200 \text{ cfs.}$$

$$Y_2 = \frac{9,300 + 7,200}{2} \cdot 3000 \cdot \frac{1}{43560} = 565 \text{ ac-ft.}$$

$$V_{av} = 685 \text{ ac-ft.}$$

$$Q_{P_2} = 85,300 \left(1 - \frac{685}{1800}\right) = 52,900 \text{ cfs.}$$

HGL Elevations: $\left\{ \begin{array}{l} \text{Just downstream of Dam} = 103.00 \\ \text{Upstream of Rt. 133} = 49.60 \\ \text{Downst. of Rt. 133} = 39.5 \end{array} \right.$
 (From preliminary stage-discharge curves)

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 DETAIL: Haskell Bend Dam CHECKED BY: D.J.D. REVIEWED BY: A.L.S.

PAGE: 9

DATE: 2/7/79

REVIEWED BY: A.L.S.

Reach 2 (Between Route 177 and Walker street) :

$$Q_{P_1} = 52,900 \quad S_2 = 1800 - 685 = 1,115$$

$$V_1 = \frac{9,800 + 30,500}{2} \cdot 1,600 \cdot \frac{1}{43,560} = 740 \text{ ac-ft}$$

$$Q_{P_2} (\text{trial}) = 52,900 \left(1 - \frac{740}{1,115}\right) \approx 18,000 \text{ cfs}$$

$$V_2 = \frac{6,300 + 19,500}{2} \cdot 1,600 \cdot \frac{1}{43,560} = 474 \text{ ac-ft}$$

$$V_{av} = \frac{740 + 474}{2} = 607 \text{ ac-ft.}$$

$$Q_{P_2} = 52,900 \left(1 - \frac{607}{1,115}\right) = 24,300 \text{ cfs.}$$

Walker st. - Upstream HGL El. = 31.0 (From Stage-Discharge Curve)

Reach 3 (Between Walker & Concord sts) :

$$Q_{P_1} = 24,300 \quad S_3 = 1,115 - 607 = 508 \text{ ac-ft.}$$

HGL El. downstream of Walker st = 27.0 (from Stage-Discharge Curve)

$$V_1 = \frac{15,200 + 4,460}{2} \cdot 2,200 \cdot \frac{1}{43,560} = 496 \text{ ac-ft.}$$

$$Q_{P_2} (\text{trial}) = 24,300 \left(1 - \frac{496}{510}\right) = 668 \text{ cfs.}$$

HGL El. Concord st: 10.1

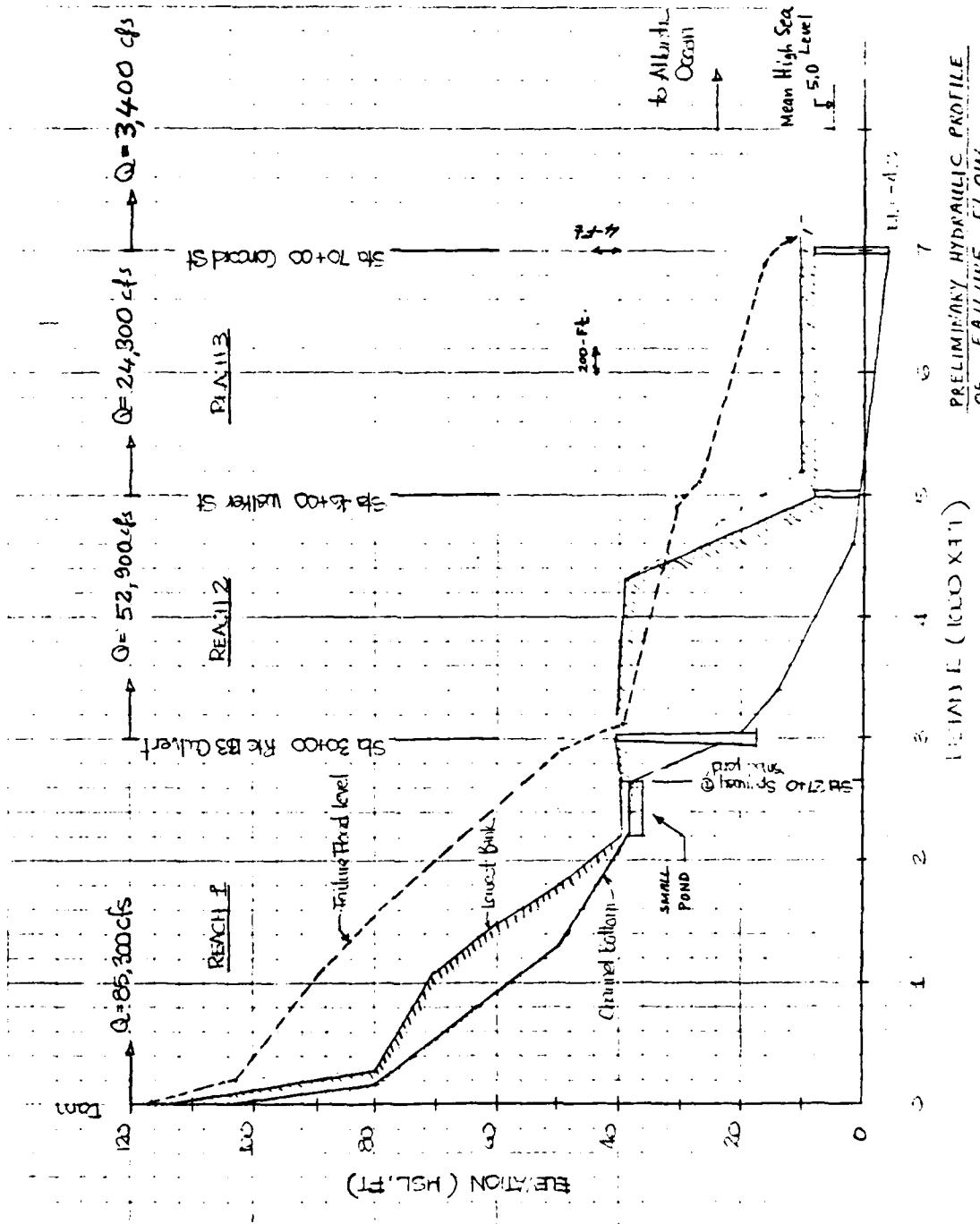
$$V_2 = \frac{15,200 + 150}{2} \cdot 2,200 \cdot \frac{1}{43,560} = 387 \text{ ac-ft.}$$

$$V_{av} = 441 \text{ ac-ft.}$$

$$Q_{P_2} = 24,300 \left(1 - \frac{441}{510}\right) = 3,400 \text{ cfs.}$$

HGL El. @ Concord st (upstream) = 16.0

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Failure Flood Impact

Location	Property affected	Estimated Depth of Inundation (Ft.)
Just downstream of Dam	Pump Stn.	20
Between Dam & Route 133		
Left Bank	2 dwellings	12
	Rt. 133	10
Between Rt. 133 & Walker St.		
Left Bank	5 dwellings	10
	2	5
	Walker St.	20
Between Walker St. & Concord St.		
Left Bank	3 dwellings	5
Right Bank	5 dwellings	10
	5 dwellings	5
	Concord St.	7

Note: Q_p would be equal to 66,300 cfs if the dam embankment length at the midheight (350 ft.) is utilized. However, the conclusions indicated above would not be affected.

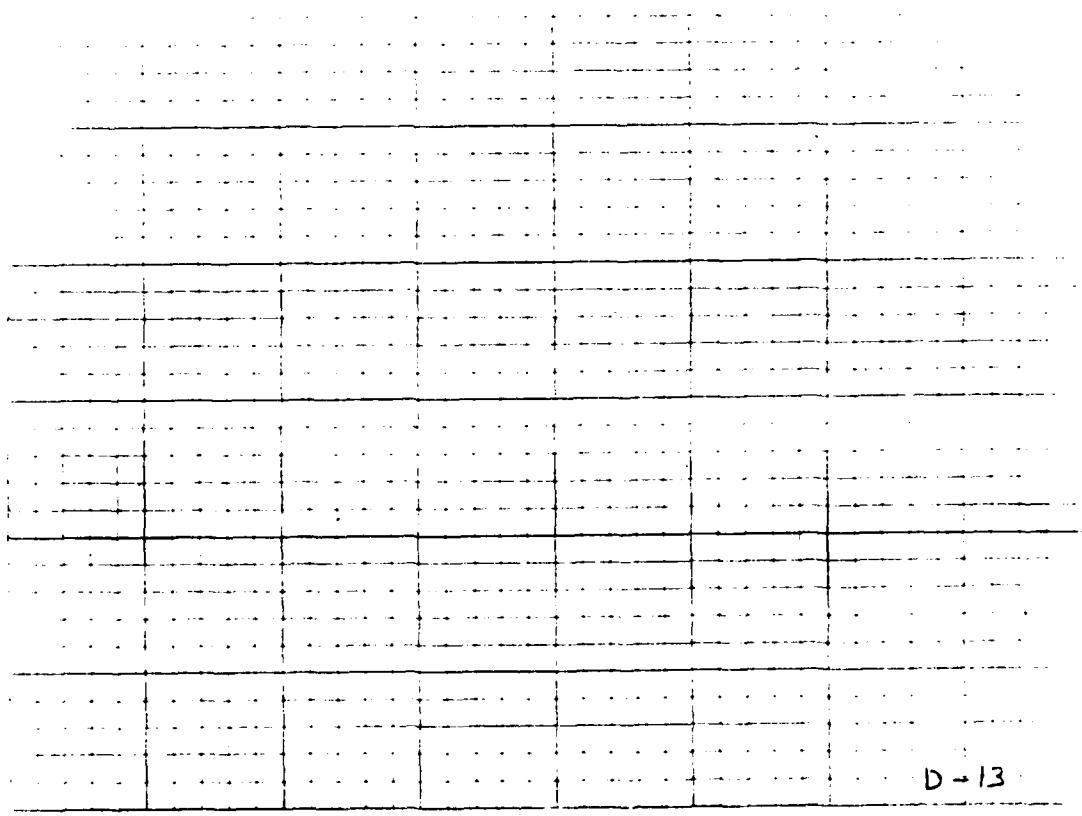
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DOWNSTREAM CHANNEL

CROSS SECTIONS

AND

STAGE-DISCHARGE RELATIONS



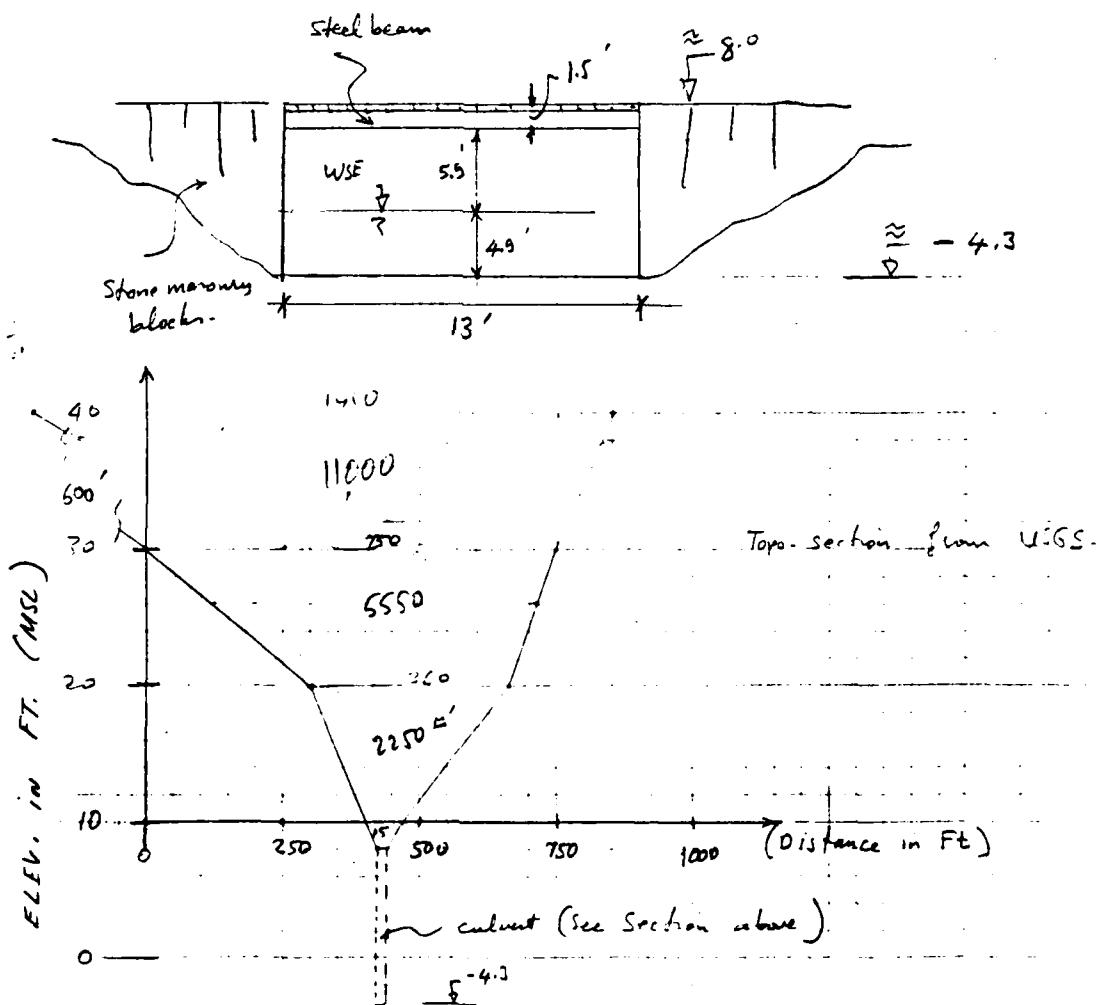
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D-13

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Bridge on the Concord Rd.

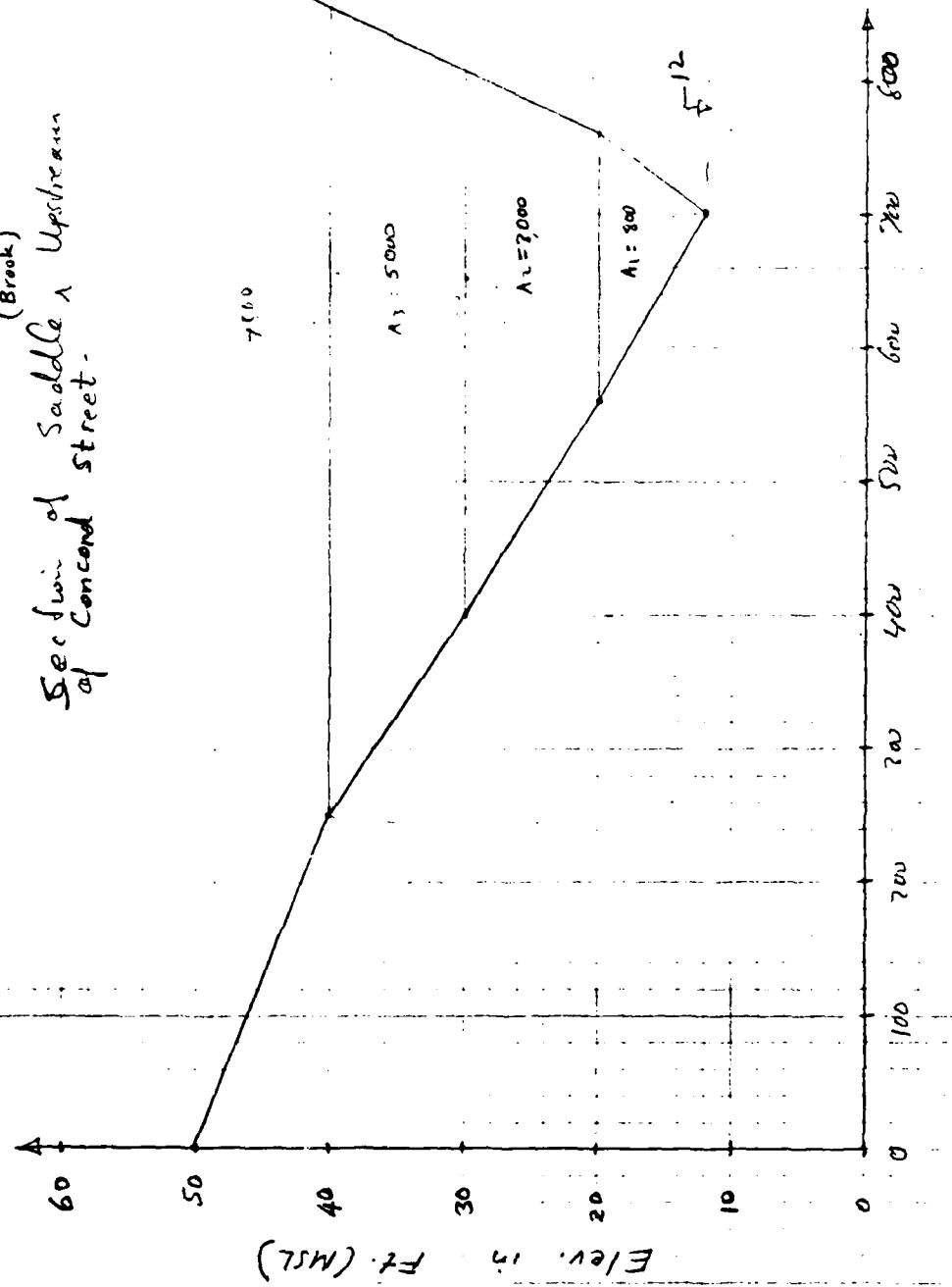
Steel girder deck. $L = 13'$



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Section of Saddle Brook
Upstream
of Concord street.



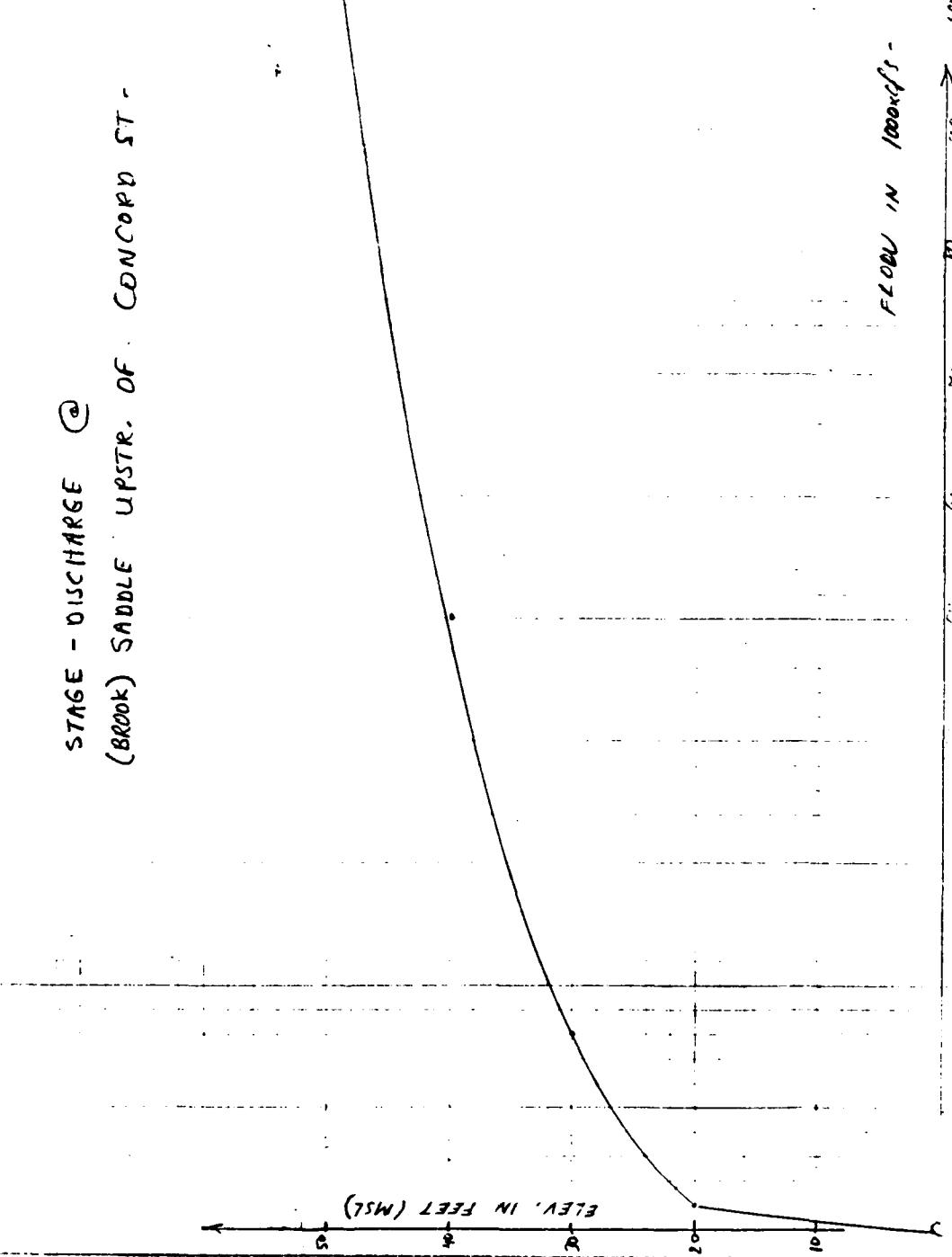
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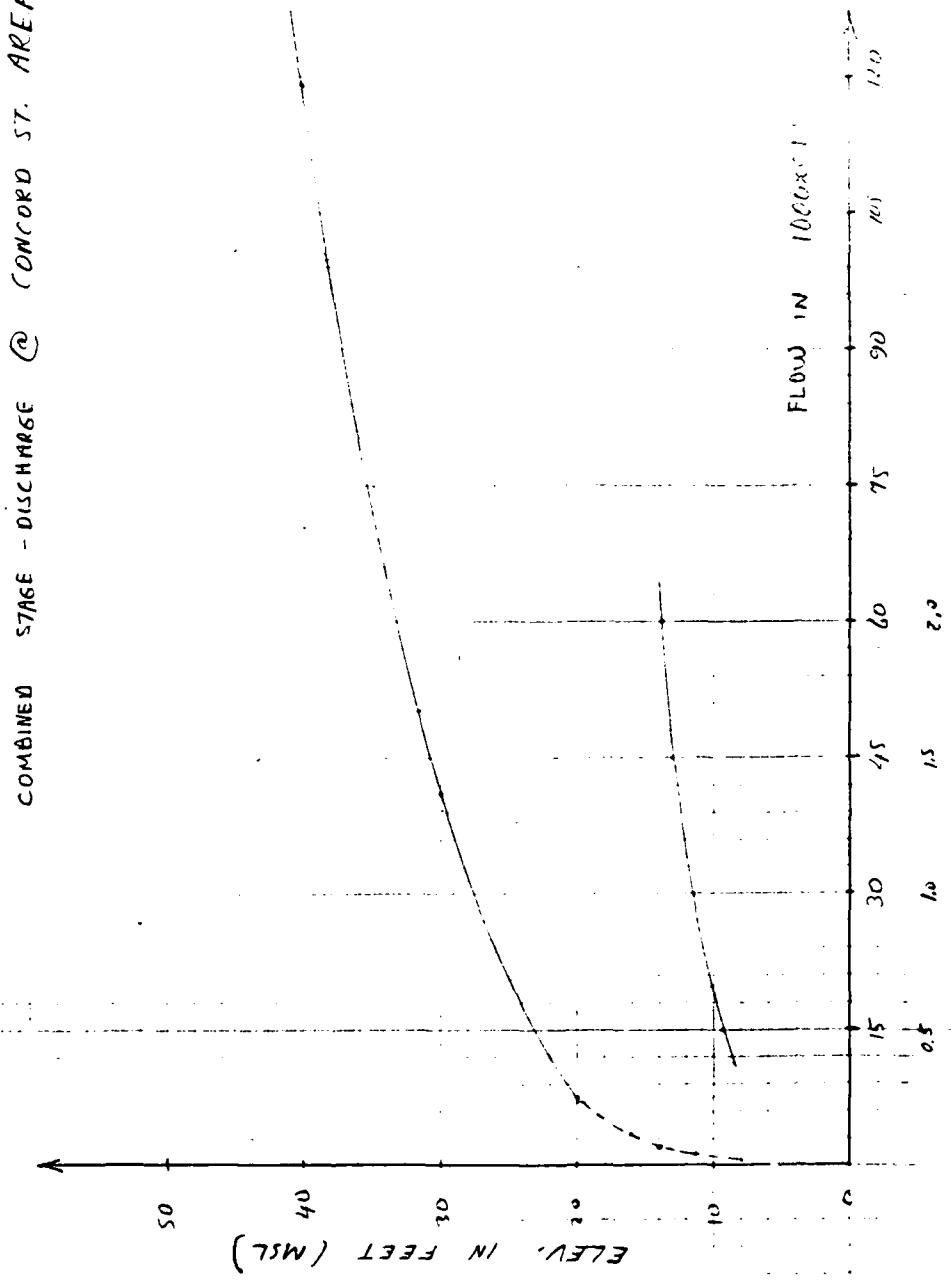
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STAGE - DISCHARGE @
(BROOK) SADDLE UPSTR. OF CONCORD ST.



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COMBINED STAGE - DISCHARGE @ CONCORD ST. AREA -



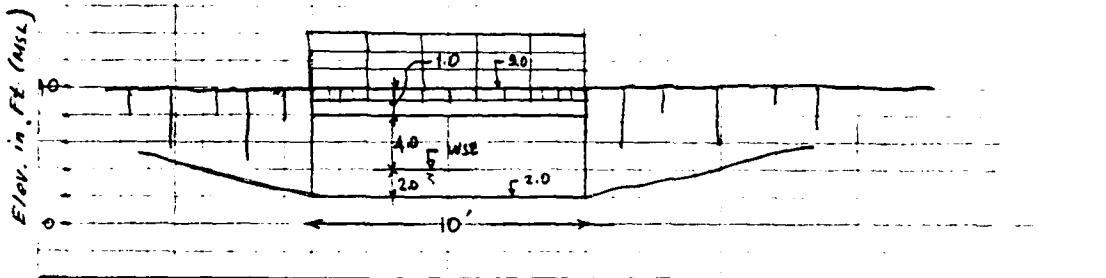
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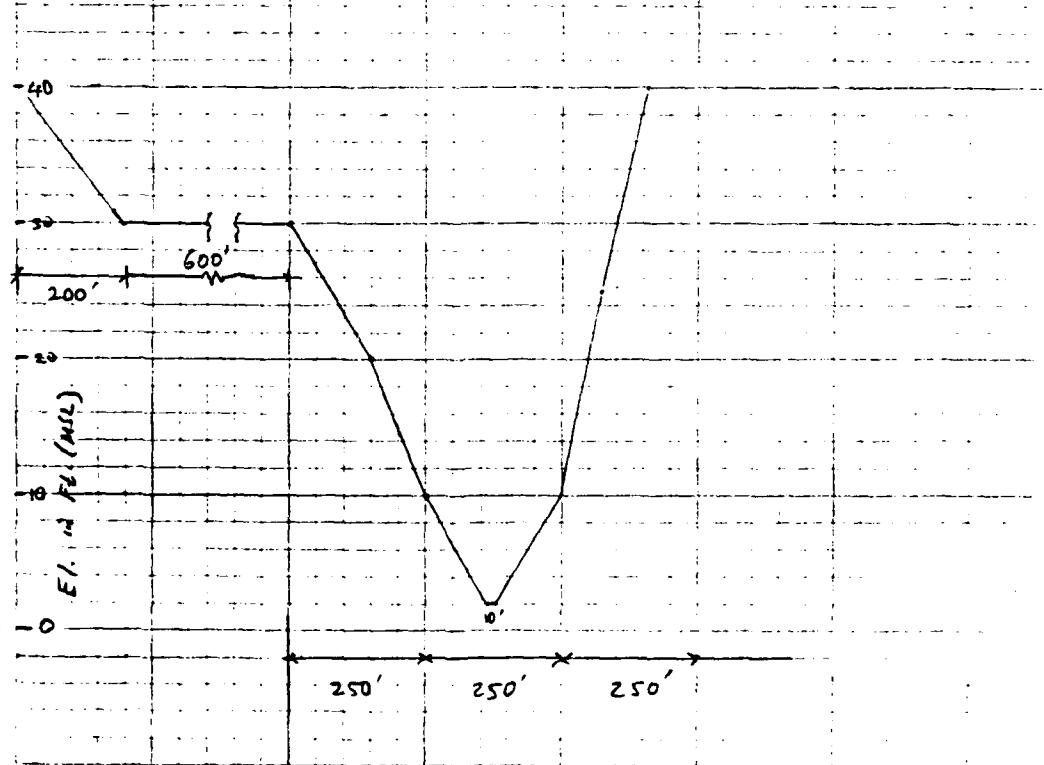
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1- Timber Bridge Crossing on Walker Rd.



2- channel Section (a) downstream of Walker St.



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HASKELL POND DAM (MA.) (U) CORPS OF ENGINEERS WALTHAM MA
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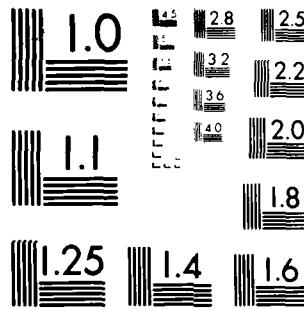
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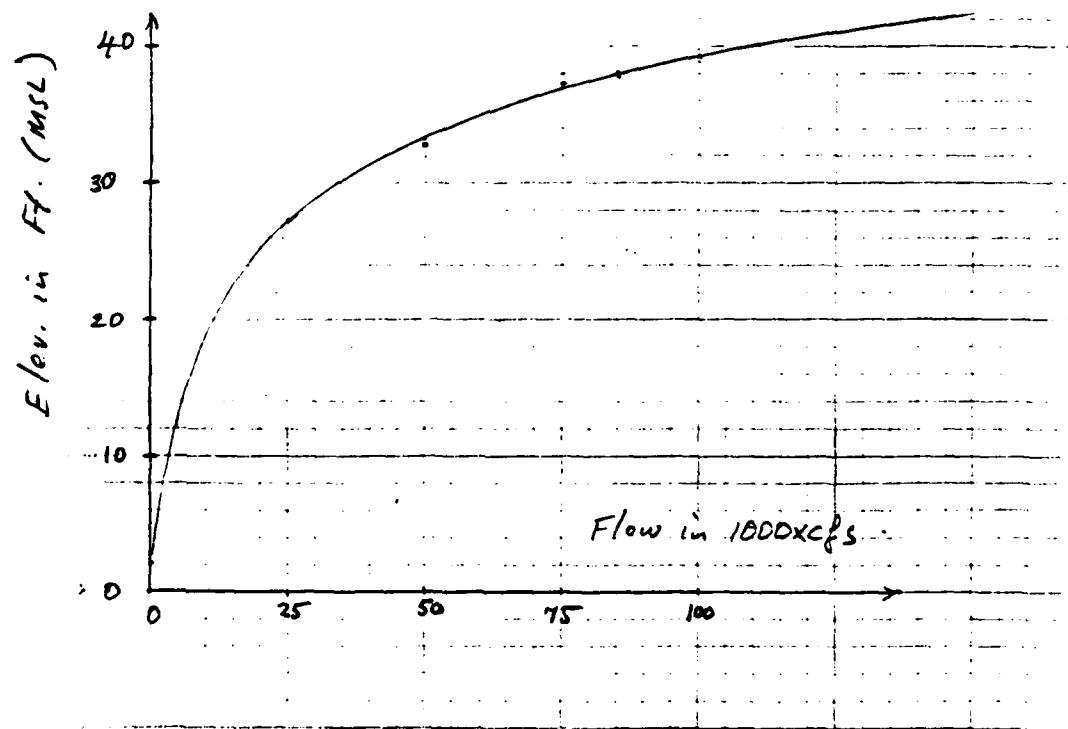
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Stage - Discharge (Cont'd)

2- At Walker Street

a- Downstream :

<u>Q</u> <u>1000 cfs</u>	<u>S₁</u>	<u>Δh</u>	<u>HGL El.</u>		<u>disches</u>	<u>Surf</u>	<u>Surf</u>	<u>El. at</u> <u>Walker</u>
			<u>at Concord</u>	<u>at Miller</u>				
25	0.0005x25 = 12	1.2	26.2	27.4	25.0	0.0034	0.0042	27.2
50		1.2	31.7	32.9	31.0	0.0044	0.0047	32.8
75		1.2	36.4	37.6	35.1	0.0040	0.0045	37.4
100		1.2	38.1	39.3		0.0050	0.0055	39.3

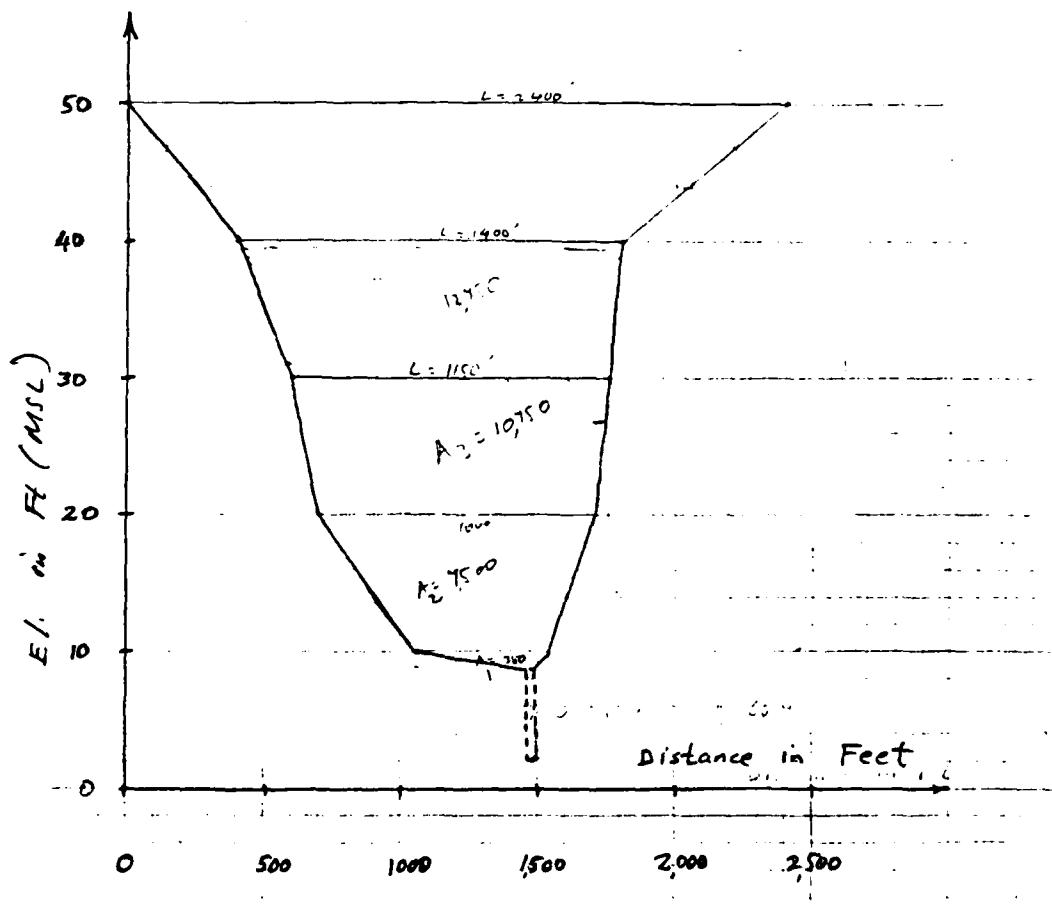


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Stage-Discharge Curves (Cont'd)

channel Section @

Upstream of Walker St.



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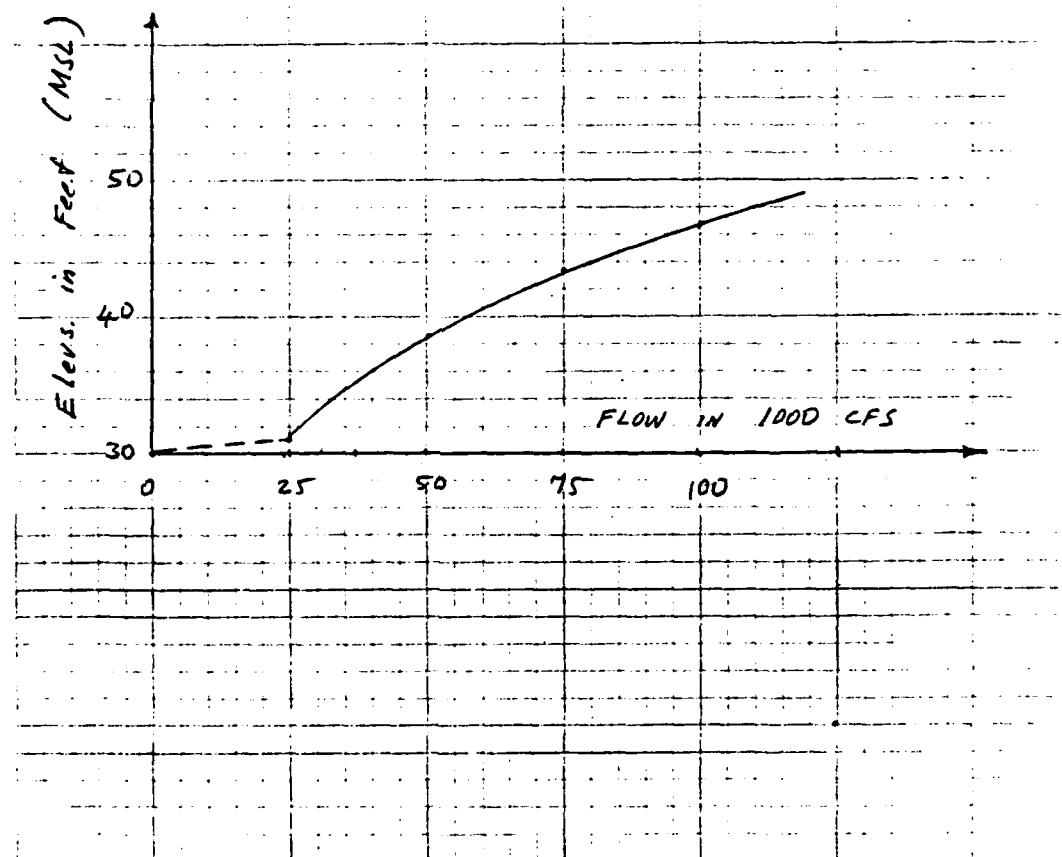
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STAGE - DISCHARGE CURVE

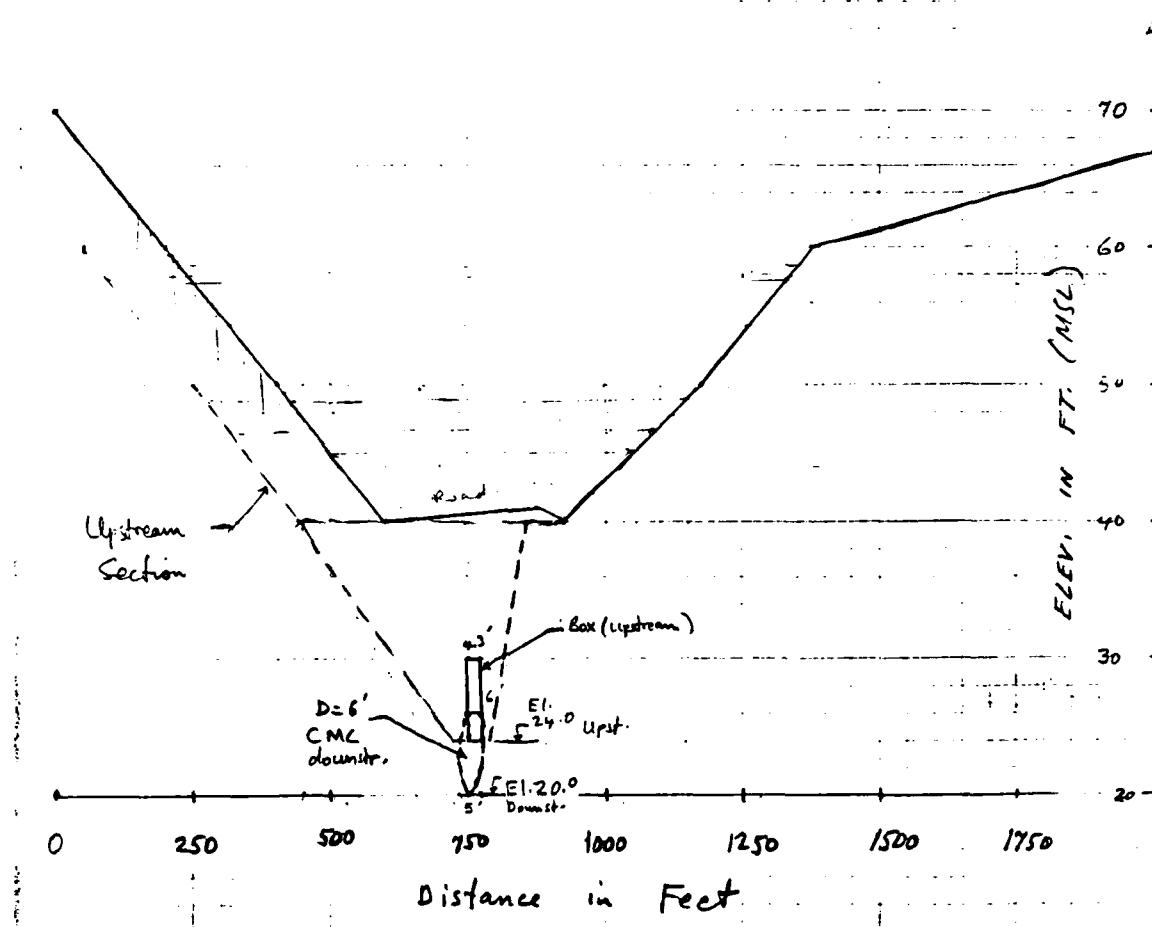
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UPSTREAM OF WALKER ST.



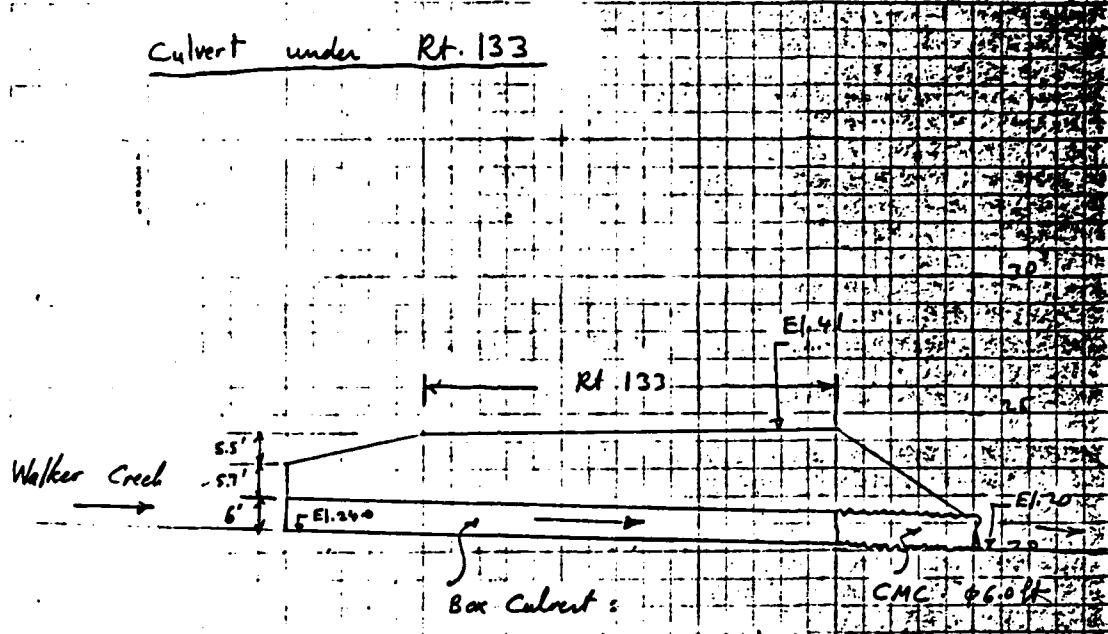
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(Downstream Channel)
 Walker Creek Section @ Route 133

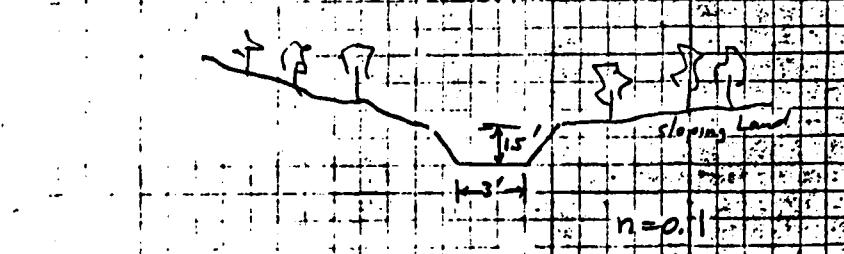


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Culvert under Rt. 133



Stream bed upstream of Hwy. culvert



Stream bed has a relatively very small capacity

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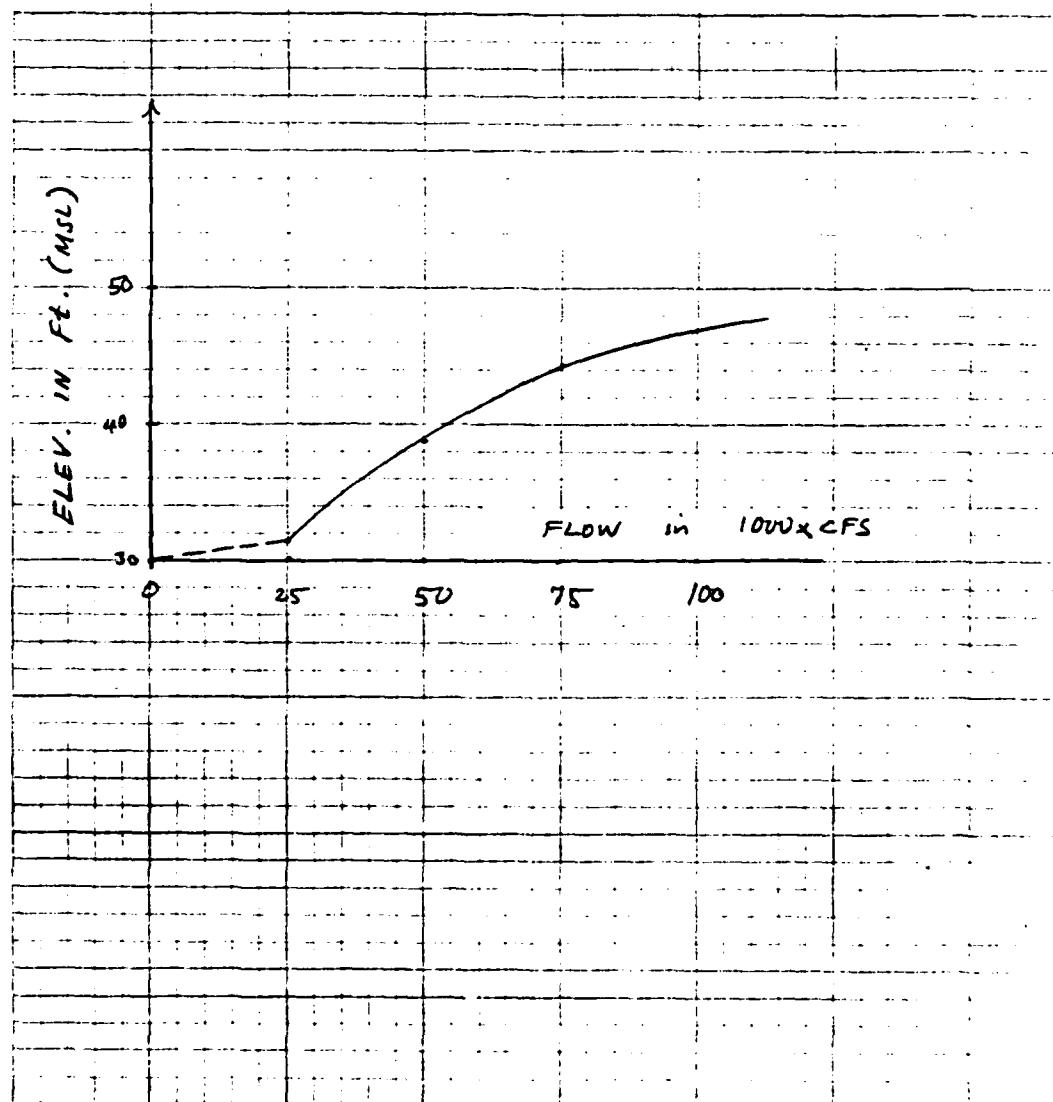
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STAGE - DISCHARGE CURVE

Downstream of Route 133



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PROJECT COF Dam
DETAIL Haskell Pond Dam

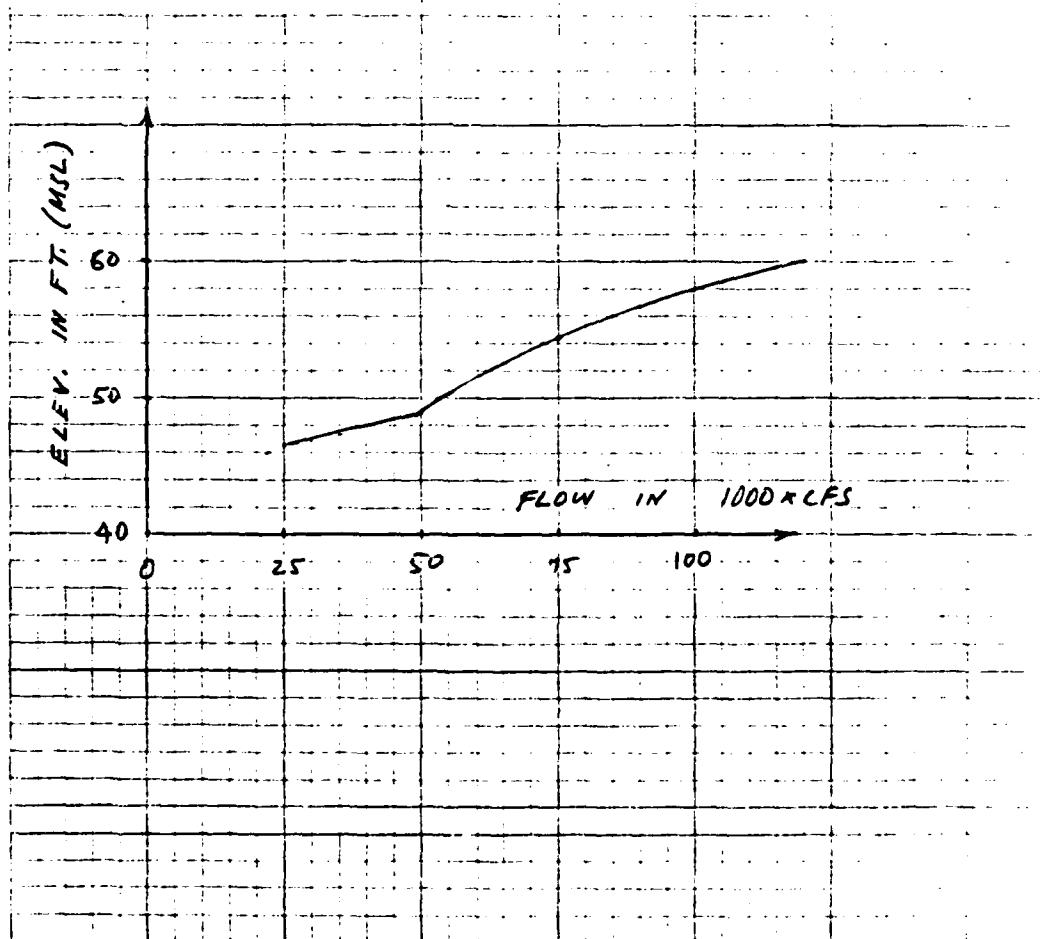
JOB NO 561-9-RT-18
DATE CHECKED 9/10/79
CHECKED BY PK

PAGE 12
DATE 9/7/79
COMPUTED BY PK

STAGE - DISCHARGE CURVE

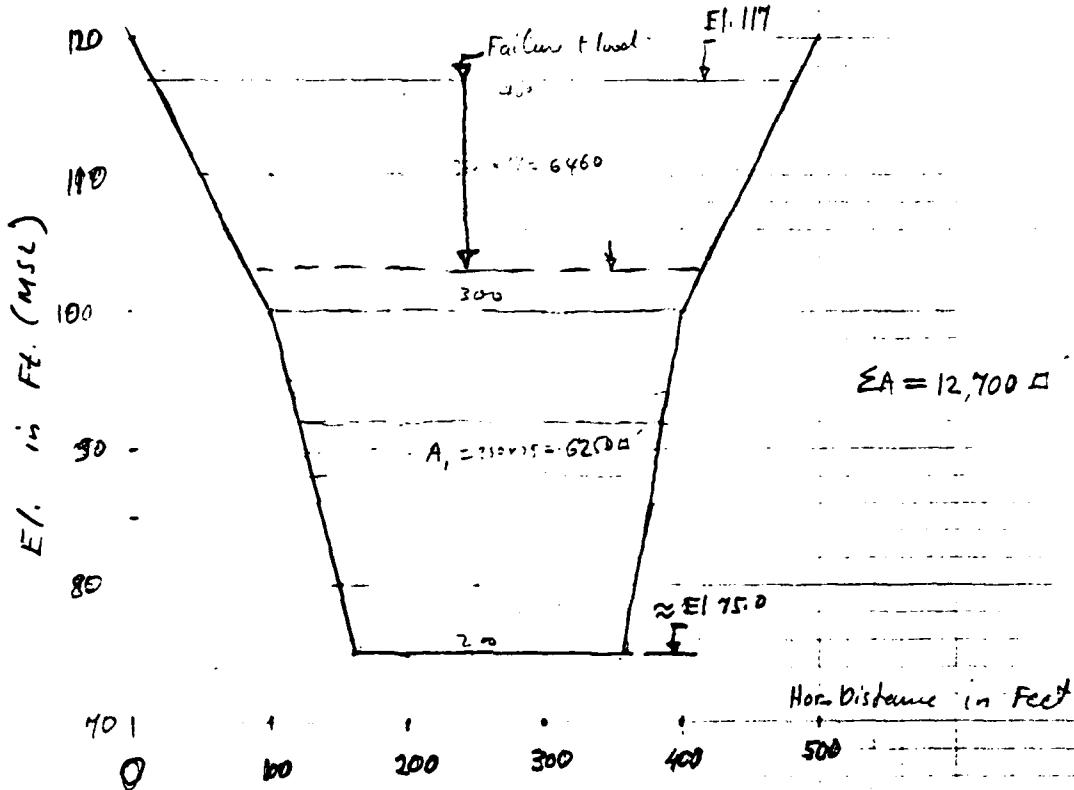
@

UPSTREAM OF RT. 133



CAMP DRESSER & MCKEE
Environmental Engineers
Boston, Mass. CLIENT H-2 A
PROJECT COF Dam Imp.
DETAIL Heckell Pond JOB NO 561-9-Pt-18
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COMPUTED BY AVG

Flood Plain Section = downst. of Dam



Tail Water Elev. @ Failure Flood

$$Q = 85,300 \quad S = \frac{117 - 50}{3000} = 0.022 \quad \sqrt{S} = 0.15$$

$$85,300 = \frac{1.5}{0.035} AR^{2/3} - 0.15 \quad AR^{2/3} = 13,290$$

$$Elev. 100 \quad h = 25 \quad A = 6250 \quad R^{2/3} = 7.4 \quad AR^{2/3} = 46,000$$

$$Elev. 90 \quad h = 15 \quad A = 230 \times 15 = 3450 \quad R^{2/3} = 5.4 \quad AR^{2/3} = 17,500$$

$$Elev. 88 \quad h = 13 \quad A = 225 \times 13 = 2925 \quad R^{2/3} = 4.6 \quad AR^{2/3} = 13,360$$

$$ELEV = \frac{88 + 117}{2} \approx 103.0$$

CAMP DRESSER & MCKEE CLIENT H-5A
Environmental Engineers PROJECT COE Dam Inspection
Benton, Mo. DETAIL Haskell Pond Dam

JOB NO. 521-9-PR-16 COMPUTED BY PLATE
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Section of Saddle
Between Haskell Pond
and Cedar Swamp

$S = 1.41$
 $n = 35$
 $h = 0.05$

APPENDIX E - INFORMATION AS CONTAINED IN
THE NATIONAL INVENTORY OF DAMS